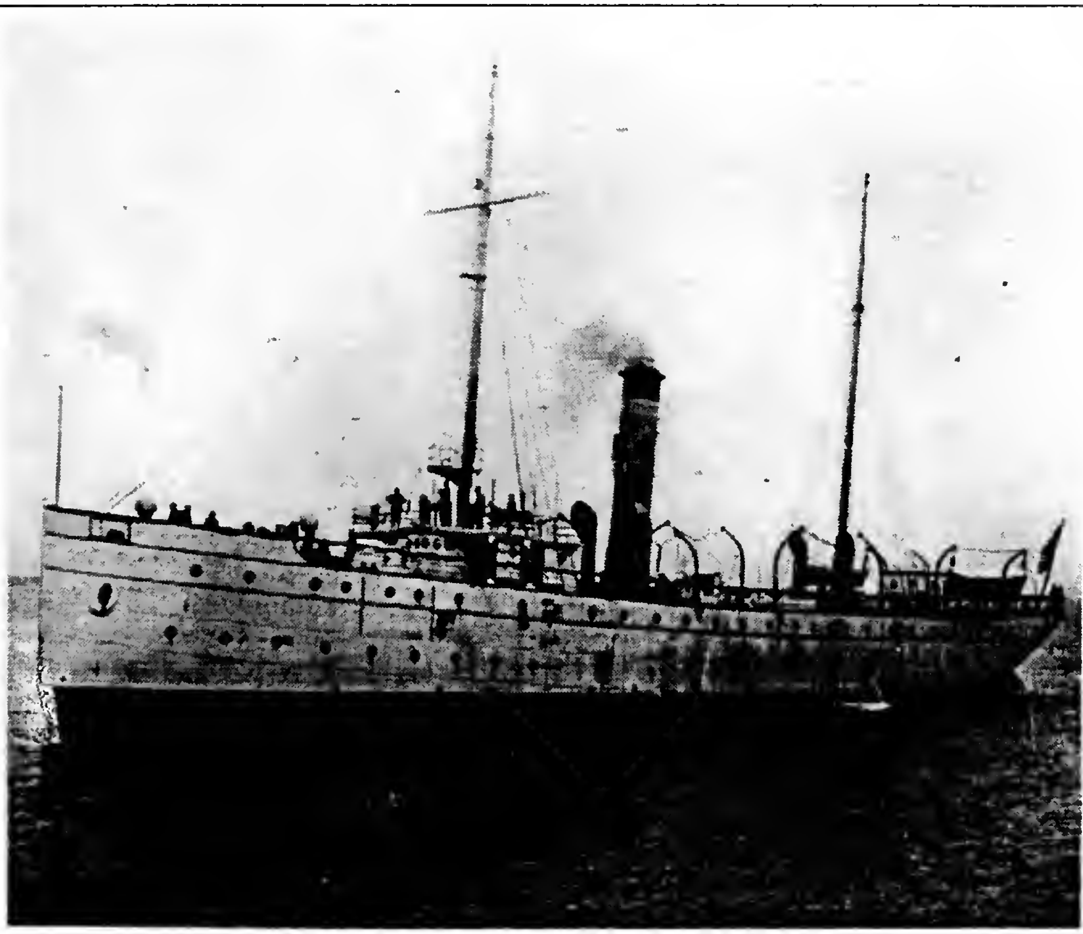
Shelve: Bulletin of the United States Coast Guard

U. S. Department
of Transportation
**United States
Coast Guard**

Report of the International Ice Patrol in the North Atlantic



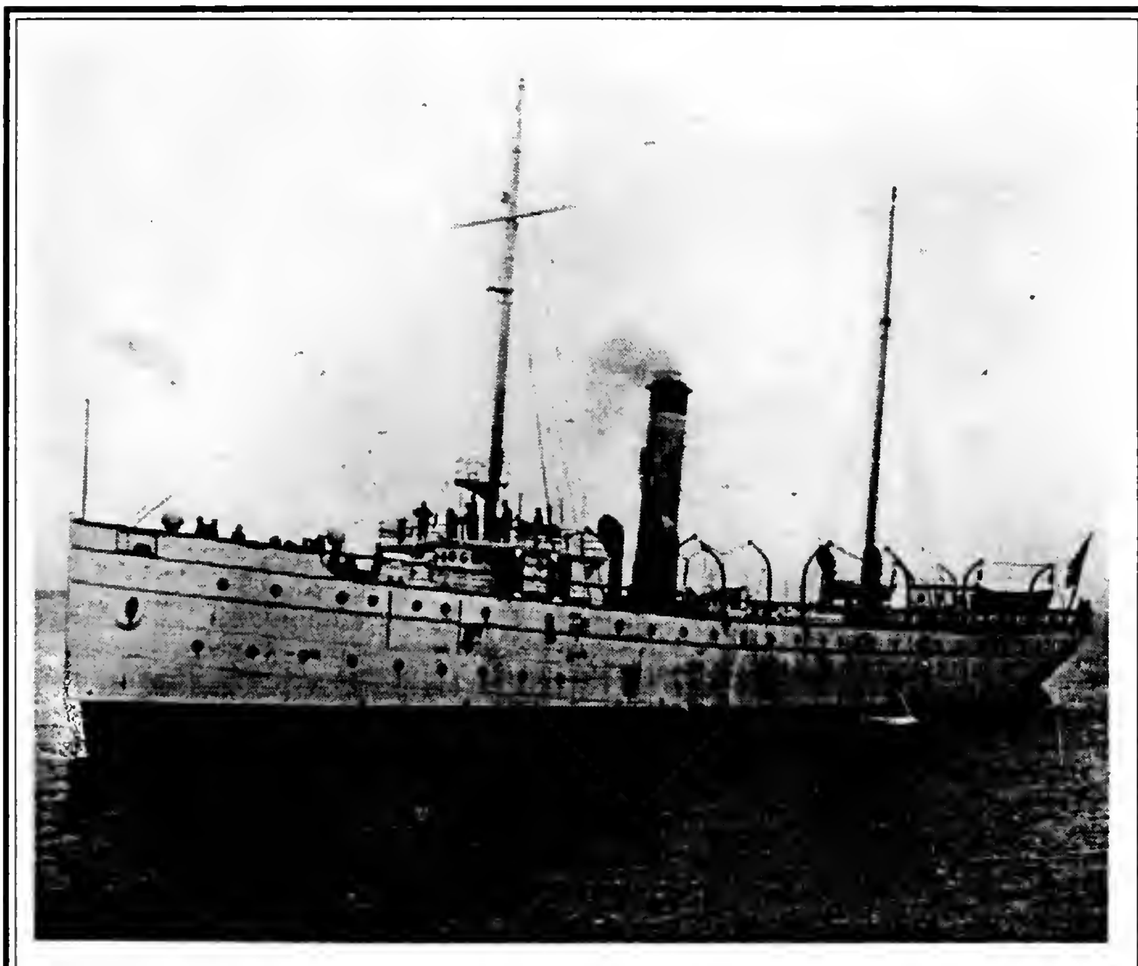
GB
2427
.N5
U5
no. 81

1995 Season
Bulletin No. 81
CG-188-50

Shelve: Bulletin of the United States Coast Guard

U. S. Department of Transportation
United States Coast Guard

Report of the International Ice Patrol in the North Atlantic



1995 Season
Bulletin No. 81
CG-188-50

GB 2427 .N5 U5 no. 81

Bulletin No. 81

REPORT OF THE INTERNATIONAL ICE PATROL IN THE NORTH ATLANTIC

Season of 1995

CG-188-50

Forwarded herewith is Bulletin No. 81 of the International Ice Patrol, describing the Patrols's services, ice observations and conditions during the 1995 season.

R. A. ROOTH
Commander, U. S. Coast Guard
Chief, Icebreaking Division

MBL/WHOI
0 0301 0037852 7

International Ice Patrol 1995 Annual Report

Contents

Cover: U. S. Revenue Cutter SENECA (1908-1942)

Length: 240 feet
Top Speed: 12 knots
Armament: Two 6-pounder guns (largest carried by the Revenue Cutter Service in peacetime)

The first Revenue Cutter assigned to Ice Patrol on the Grand Banks.

SENECA was constructed in 1908, specifically for the purpose of dealing with derelict vessels abandoned at sea. In 1913, SENECA was detailed as the first Ice Patrol vessel for the Revenue Cutter Service (now the U.S. Coast Guard). The U.S. Navy performed the Ice Patrol starting immediately after the TITANIC disaster in 1912, and the International Ice Patrol was officially established in early 1914.

Introduction

This is the 81st annual report of the International Ice Patrol (IIP). It contains information on Ice Patrol operations, environmental conditions, and ice conditions for the 1995 IIP season. The U.S. Coast Guard conducts the Ice Patrol in the North Atlantic under the provisions of U.S. Code, Title 46, Sections 738, 738a through 738d, and the International Convention for the Safety of Life at Sea (SOLAS), 1974. The IIP is supported by 17 member nations (Appendix A). It was initiated shortly after the sinking of the RMS TITANIC on April 15, 1912 and has been conducted seasonally since that time.

Commander, International Ice Patrol (CIIP) is under the operational control of Commander, Coast Guard Atlantic Area. CIIP directs the Ice Patrol from its Operations Center in Groton, Connecticut. IIP receives iceberg location reports from ships and planes transiting its patrol area and conducts aerial Ice Reconnaissance Detachments (ICERECDETs) to survey the southeastern, southern, and southwestern regions of the Grand Banks of Newfoundland for icebergs. IIP analyzes ice and environmental data and employs an iceberg drift and deterioration model to produce twice-daily iceberg warnings, which are broadcast to mariners as ice bulletins and facsimile charts. IIP also responds to requests for iceberg information. IIP's ICERECDETs were based in St. John's, Newfoundland, Canada during the 1995 season.

Vice Admiral James M. Loy was Commander, Atlantic Area. CDR Ross L. Tuxhorn was Commander, International Ice Patrol.

Summary of Operations, 1995

The 1995 IIP year (October 1, 1994 - September 30, 1995) marked the 81st anniversary of the International Ice Patrol, which was established February 7, 1914. IIP's operating area is enclosed by lines along 40 N, 52 N, 39 W and 57 W (Figure 1).

IIP's first preseason aerial ICERECDET of the year departed on January 23. The 1995 IIP season was opened on February 28 and from this date until August 2, 1995 an ICERECDET operated from Newfoundland every other week. The season officially closed on August 1, 1995.

IIP's Operations Center in Groton, Connecticut analyzed the iceberg sighting information from the ICERECDETs, ships, Canadian Ice Services (CIS) sea ice/iceberg reconnaissance flights, and other sources. Air reconnaissance, consisting of Coast Guard (IIP), Other Air Recon, and CIS was the major source of iceberg sighting reports this season, accounting for 66.7% of the icebergs sighted in 1995 (Table 1). Ships provided 18.3% of the iceberg sightings received by IIP in 1995. Their continued active participation indicates the value that they place on IIP's service. In 1995 302 ships of 41 different nations provided ice information to IIP. This demonstrates the number of nations using the services of and contributing to IIP far exceeds the 17 member nations underwriting IIP under SOLAS 1974. Appendix B lists the ships that provided iceberg sighting reports, including reports of radar targets. In Appendix B, a single report may contain multiple targets.

The largest contributor of air reconnaissance reports was Provincial Airlines Limited (PAL). Their reports accounted for nearly all of the category "Other Air Recon" on Table 1. Provincial Airlines Limited is a private company that provides aerial reconnaissance services for the Canadian Department of Fisheries and Oceans (DFO) year round, and for AES June through December. DFO flights, which are designated to monitor the activities of fishing vessels, frequently carry them to areas with high iceberg concentra-

Table 1
Sources of All Sightings
Entered into IIP's Drift Model

Sighting Source	Percent of Total
Coast Guard (IIP)	15.4
Other Air Recon	34.8
Canadian AES	16.5
BAPS	14.9
Ships	18.3
Other	0.1

Table 2
Sources of All Sightings
South of 45°N

Sighting Source	Percent of Total
Coast Guard (IIP)	55.5
Other Air Recon	23.4
Canadian AES	0
BAPS	0
Ships	21.1
Other	0

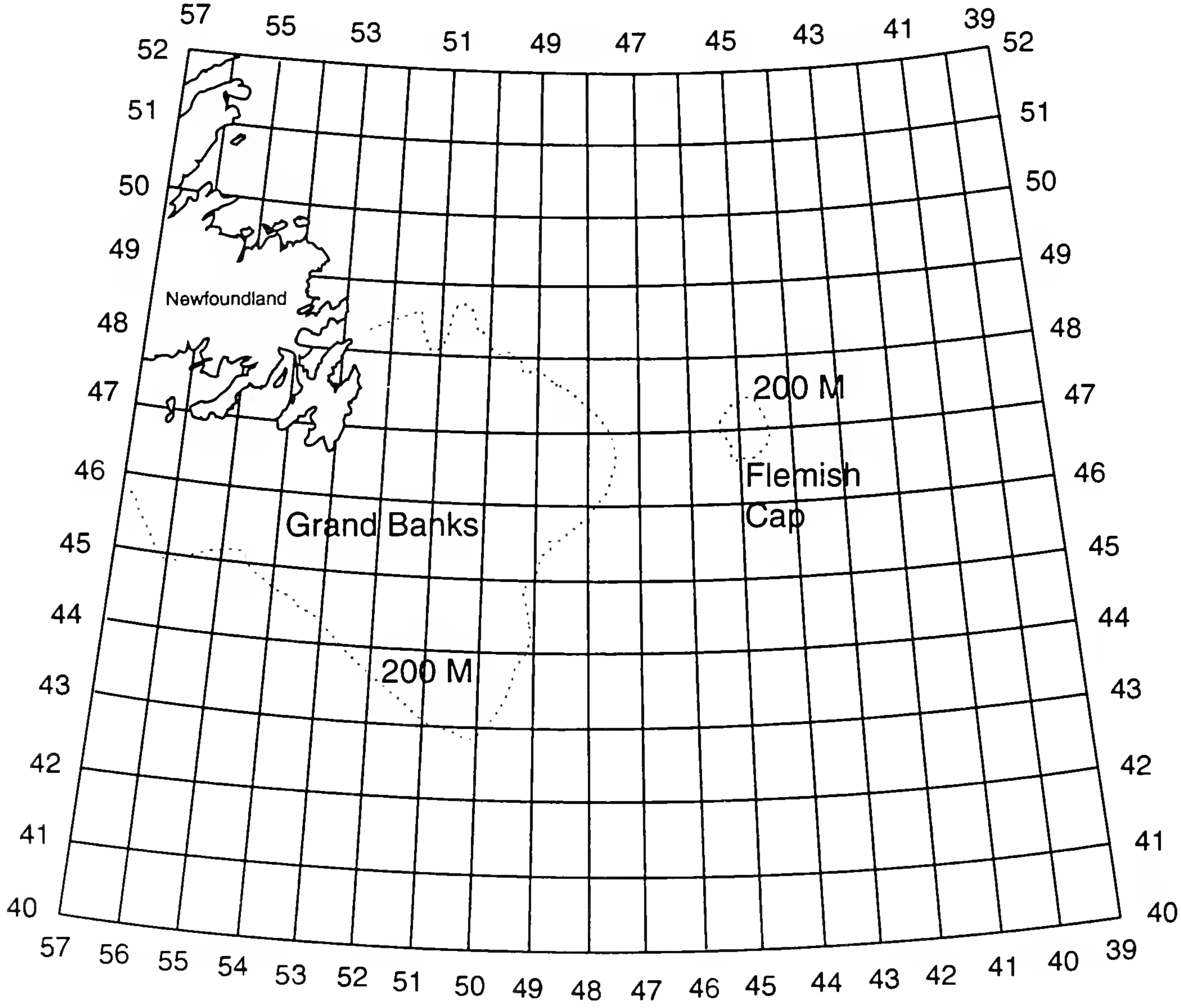


Figure 1
International Ice Patrol's Operation Area showing bathymetry of the Grand Banks of Newfoundland

tions. The next largest contribution to the air reconnaissance total was from IIP ICERECDETs. IIP flights concentrate on defining the boundaries of the iceberg distribution (Appendix C). These are typically areas of low iceberg concentration. Table 2 shows the increased relative contribution of the IIP flights near the limits. BAPS sightings are icebergs detected north of 52 N primarily by AES reconnaissance. These are passed to IIP by AES as the icebergs cross into the Ice Patrol operating area. AES acquired and relayed to IIP iceberg information obtained during sea ice reconnaissance flights and a few flights dedicated solely to iceberg reconnaissance.

During 1995, the IIP Operations Center received a total of 7962 target sightings within its operations area which were entered into IIP's drift model. This is comparable to the 9496 target sightings during 1994. The 7962 targets entered into IIP's drift model do not represent all of the targets reported to IIP. Sightings of targets out-

side IIP's Area of Responsibility (AOR) were not entered into the model. Most of these were far to the north of IIP's AOR in areas not covered by IIP's model. Coastal iceberg sightings were also screened, and only those with the potential to drift into the trans-Atlantic shipping lanes were entered into the IIP model.

Table 3 includes icebergs detected south of 48 N plus the number of icebergs which were predicted to drift across 48 N for each month of 1995. During the 1995 ice year, an estimated 1432 icebergs drifted south of 48 N; whereas, during 1994, 1765 icebergs had drifted south of 48 N.

Table 3
Number of Icebergs South of 48°N

Number of Icebergs South of 48°N during 1995

Month	Number
OCT	0
NOV	0
DEC	0
JAN	0
FEB	43
MAR	385
APR	334
MAY	405
JUN	218
JUL	41
AUG	6
SEP	0
Total	1432

IIP classifies the severity of the ice seasons based on the historic iceberg counts of its entire 81 year history. Ice years with fewer than 300 icebergs crossing 48 N are defined as light ice years; those with 300 to 600 crossing 48 N as moderate; and those with more than 600 crossing 48 N as extreme (Appendix C). 1995 was an extreme year for iceberg conditions.

The 1995 season was the third year that IIP used its iceberg Data Management and Prediction System (DMPS). This system, which is nearly identical to the iceBerg Analysis and Prediction System (BAPS) used at the Canadian Ice Centre, Ottawa, combines an iceberg drift model with a deterioration model. The model uses wind, ocean current, and iceberg size data to predict the movement and deterioration of all ice bergs entered into DMPS. The drift prediction model uses a new historical current data base which is modified weekly using satellite-tracked ocean drifting buoy data, thus taking into account local, short-term, current fluctuations. Murphy and Anderson (1985) described and evaluated the drift model. The iceberg deterioration model uses daily sea surface temperature and wave height information from the U.S. Navy Fleet Numerical Meteorological and Oceanography Center (FNMOC) to predict the melt of icebergs. Anderson (1983) and Hanson (1987) described the IIP deterioration model in detail.

Eleven satellite-tracked ocean drifting buoys were deployed to provide current data for IIP's iceberg drift model during the 1995 season. The buoys are similar in design to the World Ocean Circulation Experiment (WOCE) and were equipped with surface temperature sensors and a drogue centered at 50 meters. Drift data from the buoys are discussed in the IIP 1995 Drifting Buoy Atlas, which is available upon request.

During the 1995 season, IIP successfully deployed 49 Air-deployable eXpendable BathyThermographs (AXBTs), which measure temperature with depth and transmit the data back to the aircraft. Temperature data from the AXBTs were sent to the Canadian Meteorological and Oceanographic Center (METOC) in Halifax, Nova

During the 1995 season, IIP successfully deployed 49 Air-deployable eXpendable BathyThermographs (AXBTs), which measure temperature with depth and transmit the data back to the aircraft. Temperature data from the AXBTs were sent to the Canadian Meteorological and Oceanographic Center (METOC) in Halifax, Nova Scotia, Canada, the U.S. Naval Atlantic Meteorology and Oceanography Center (NLMOC) in Norfolk, Virginia, and FNMOC for use as inputs into ocean temperature models. IIP directly benefits from AXBT deployments by having improved ocean temperature data provided to its iceberg deterioration model. IIP also provided weekly drifting buoy sea surface temperature (SST) and drift histories to METOC and NLMOC for use in water mass and SST analyses. Canada's Maritime Command/Meteorological and Oceanographic Centre provided the AXBT probes for IIP use. IIP greatly appreciates the valuable support given by METOC for this program. The data collected significantly increases regional knowledge of circulation patterns and improves the capability to predict iceberg deterioration.

On April 15, 1995, IIP paused to remember the 83rd anniversary of the sinking of the RMS TITANIC. During an ice reconnaissance patrol, two wreaths were placed near the site of the sinking to commemorate the nearly 1500 lives lost.

Iceberg Reconnaissance and Communications

During the 1995 Ice Patrol year, 106 aircraft sorties were flown in support of IIP. Of these, 47 were transit flights to St. John's, Newfoundland, IIP's base of operations since 1989, and 43 were ice observation flights made to locate the southwestern, southern, and southeastern limits of icebergs. Thirteen logistics flights were required to support and maintain the patrol aircraft. Tables 4 and 5 show aircraft use for the 1995 ice year.

IIP's aerial ice reconnaissance was conducted with SLAR- and FLAR-equipped U.S. Coast Guard HC-130H aircraft. No HU-25B aircraft were used in 1995. The HC-130H aircraft used on Ice Patrol are based at Coast Guard Air Station Elizabeth City, North Carolina. The HU-25B aircraft available for Ice Patrol use are stationed at Air Station Corpus Christi, Texas.

This was the third operational year for the FLAR. Analysis of the SLAR/FLAR combination from 1993 and 1994 allowed IIP to increase search track spacing from 25 nautical miles (NM) to 30NM, resulting in a 20% increase in area covered without increasing trackline miles flown.

IIP schedules aerial iceberg surveys every other week rather than every week. This is due to the ability of the SLAR and FLAR to detect and differentiate icebergs in all weather, combined with use of the iceberg drift and deterioration computer model to track icebergs in-between sightings.

The HC-130H 'Hercules' aircraft has been the primary platform for Ice Patrol aerial reconnaissance since 1963, while the HU-25B has been used since 1988. The extent of the

Table 4
Aircraft Usage During the 1995 Ice Year

Sorties

Transit	Patrol	Research	Logistics	Total
47	43	3	13	106

Flight Hours

Transit	Patrol	Research	Logistics	Total
121.2	276.9	18.3	22.7	439.1

Table 5
Iceberg Reconnaissance Sorties

Month	Sorties	Flight Hours
JAN	1	7.8
FEB	3	13.7
MAR	6	39.9
APR	8	46.5
MAY	11	68.8
JUN	7	48.2
JUL	6	45.5
AUG	1	6.5
TOTAL	**43**	**276.9**

iceberg distribution throughout the entire 1995 season required the use of the HC-130H rather than the HU-25B. The total number of flight hours decreased from 576.6 hours in 1994 to 439.1 in 1994. The number of sorties decreased from 139 in 1994 to 106 in 1995. The largest decrease was in patrol sorties, which went from 70 in 1994 to 43 in 1995. This decrease reflects the generally smaller geographical area covered by icebergs in 1995, requiring fewer flight hours to cover the limits of all known ice.

Each day during the ice season IIP prepared and distributed ice bulletins at 0000Z and 1200Z to warn mariners of the southwestern, southern, and southeastern limits of icebergs. U. S. Coast Guard Communications Station Boston, Massachusetts, NMF/NIK, and Canadian Coast Guard Radio Station St. John's Newfoundland/VON were the primary radio stations responsible for the dissemination of the ice bulletins. In addition the 0000Z and 1200Z ice bulletin and safety broadcasts were delivered over the INMARSAT-C SafetyNet via the AOR-W satellite. Other transmitting stations for the bulletins included METOC Halifax, Nova Scotia/CFH, Canadian Coast Guard Radio Station Halifax/VCS, Radio Station Bracknel, UK/GFE, and U. S. Navy LCMP Broadcast Stations Norfolk, Virginia/NAM, and Key West, Florida.

IIP also prepared a daily facsimile chart, graphically depicting the limits of all known ice, for broadcast at 1600Z and 1810Z daily. In addition, the facsimile chart was placed on Comsat Corp's INMARSAT-A FAXMAIL Server for receipt at sea. U. S. Coast Guard Communications Station Boston/NIK assisted with the transmission of these charts. Canadian Coast Guard Radio Station St. John's Newfoundland/VON and U. S. Coast Guard Communications Station Boston/NIK also provided special broadcasts as required.

As in previous years, International Ice Patrol requested that all ships transiting the area of the Grand Banks report ice sightings, weather, and sea surface temperatures via Canadian Coast Guard Radio Station St. John's/VON, U. S. Coast Guard Communications Station Boston/NIK, or INMARSAT-C code 42. Response to this request is shown in Table 6. Appendix B lists all contributors. IIP received relayed information from the following sources during the 1995 ice year: Canadian Coast Guard Marine Radio Station St. John's/VON; Canadian Coast Guard Vessel Traffic Centre/Ice Operations St. John's; Ice Centre Ottawa; Canadian Coast Guard Marine Radio Station Halifax, Nova Scotia/VCS; ECAREG Halifax, Nova Scotia; U. S. Coast Guard Communications and Master Station Atlantic, Chesapeake, Virginia; U. S. Coast Guard Atlantic Area Command Center; and U. S. Coast Guard Automated Merchant Vessel Emergency Response/Operations Systems Center, Martinsburg, WV. Commander,

Table 6
Iceberg and Sea Surface Temperature (SST) Reports

Number of ships furnishing SST reports	34
Number of SST reports received	346
Number of ships furnishing ice reports	302
Number of ice reports received	876
First Ice Bulletin	281200Z FEB 95
Last Ice Bulletin	011200Z AUG 95
Length of Season (days)	155

International Ice Patrol extends a sincere thank you to all stations and ships which contributed reports. The vessel providing the most reports was the M/V Atlant II, a Croatian flag vessel.

Discussion of Ice and Environmental Conditions

Background

The offshore branch of the Labrador Current is the main mechanism transporting icebergs south to the Grand Banks and the North Atlantic shipping lanes (figure 2). Its relatively cold water keeps the deterioration of icebergs to a minimum.

Sea ice protects the icebergs from wave action, the major agent in iceberg deterioration. If sea ice extends to the south and over the Grand Banks of Newfoundland, the icebergs will be protected longer as they drift south. When the sea ice edge retreats in the spring, large numbers of icebergs will be left behind in the vicinity of the Grand Banks. If the time of retreat of the sea ice edge is delayed by below-normal air and sea surface temperatures, the icebergs will be protected from melt longer and be expected to survive to drift farther south. In these cases a longer than normal ice season can be expected. Less southerly sea ice extent or above normal air and sea surface temperatures may result in a shorter season.

Sea ice can impede the transport of icebergs. The degree depends on the concentration of the sea ice and the size of the icebergs. The greater the sea ice concentration, the greater the effect on iceberg drift. The larger the iceberg, the less sea ice affects its drift.

The 1995 Season

Figures 3 to 9 compare the sea ice edge during the 1995 ice year to the mean sea ice edge. The mean sea ice edges were taken from Cote (1989) and represent a 25 year average (1962-1987). The ice edge (sea ice concentration $\geq 1/10$) is taken from the daily Ice Analysis from the Ice Centre, Ottawa.

Figures 10 to 21 show the Ice Patrol Limits of All Known Ice (LAKI) and the daily sea ice edge on the 15th and the last day of each month during the ice season. The ice edge is taken from the Ice Centre, Ottawa FICN2 daily product. The edge plotted is a coarse numeric representation of the daily Ice Analysis. These figures show the distribution of all icebergs and radar contacts tracked by IIP's model at the indicated times. Numerals are given for clarity for those one-degree squares where six or more targets are located.

The following is a discussion of the ice conditions, comparing those ice conditions observed and modeled in 1995 with the twenty-year IIP climatological LAKI (see Appendix E).

December through February

Through the period, sea ice growth along the Labrador Coast and in East Newfoundland waters appeared to be 2-4 weeks ahead of normal (Figures 3-5). The sea ice edges were observed further east and south than mean positions. At the end of February, 43 icebergs were south of 48°N and the reported LAKI (Figure 10) approximated the climatological median position for March 15, thus triggering the start ofthe Ice Patrol season on 28 February.

March

Throughout the month of March, a tongue of sea ice extended eastward to approximately 46°N, 47°W, implying significant surfact circu-

lation towards the east. The reported LAKI positions for March (Figures 11-12) extended eastward to 40°W, which is between the 25th percentile and extreme climatological LAKI's on the east and south. There were 385 icebergs south of 48°N and the southern extent of the LAKI at the end of March was 40°N.

April

For the first half of the month the sea ice tongue remained extended to 46°N, 47°W, after which the sea ice rapidly melted and the edge receded to the north and the Labrador-Newfoundland coastlines. IIP's LAKI was reported near the 25th percentile climatological LAKI for the entire period (Figures 13-14). There were 334 icebergs south of 48°N in April.

May

Sea ice destruction occurred at normal rate. However, remnants persisted along the coast of Newfoundland. The reported LAKI on 15 May (Figure 15) fell between the climatological median and 25th percentile on the east. However, on the south, it was near the extreme climatological limit. At the end of May, the reported LAKI (Figure 16) reflected the median climatological limit on the east and the 25th percentile climatological limit in the southern area. There were 405 icebergs that crossed 48°N in May.

June

The sea ice edge retreated above 52°N (Figure 9). The IIP LAKI (Figures 17-18) approximated the median climatological LAKI in the east and the exreme climatological LAKI in the south. There were 218 icebergs south of 48°N.

July

Reported LAKI (Figures 19-20) also matched up well with the median climatological LAKI for July. There were 39 icebergs south of 48°N by the end of July. On 1 August, the Ice Patrol season closed, with the LAKI (Figure 21) lying north of 45°N and west of 48°W.

●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●

References

Anderson, I. Iceberg Deterioration Model, Report of the International Ice Patrol in the North Atlantic, 1983 Season, CG-188-38, U.S. Coast Guard, Washington D.C., 1983.

Cote, P.W., Atmospheric Environment Service (AES), Ice Limits Eastern Canadian Seaboard, 1989, Ottawa, Ontario, K1A 0H3.

Hanson, W.E., Operational Forecasting Concerns Regarding Iceberg Deterioration, Report of the International Ice Patrol in the North Atlantic, 1987 Season, CG-188-42, U.S. Coast Guard, Washington, D.C., 1987.

Murphy, D.L. and I. Anderson, Evaluation of the International Ice Patrol Drift Model, Report of the International Ice Patrol in the North Atlantic, 1985 Season, CG-188-40, U.S. Coast Guard, Washington, D.C., 1985.

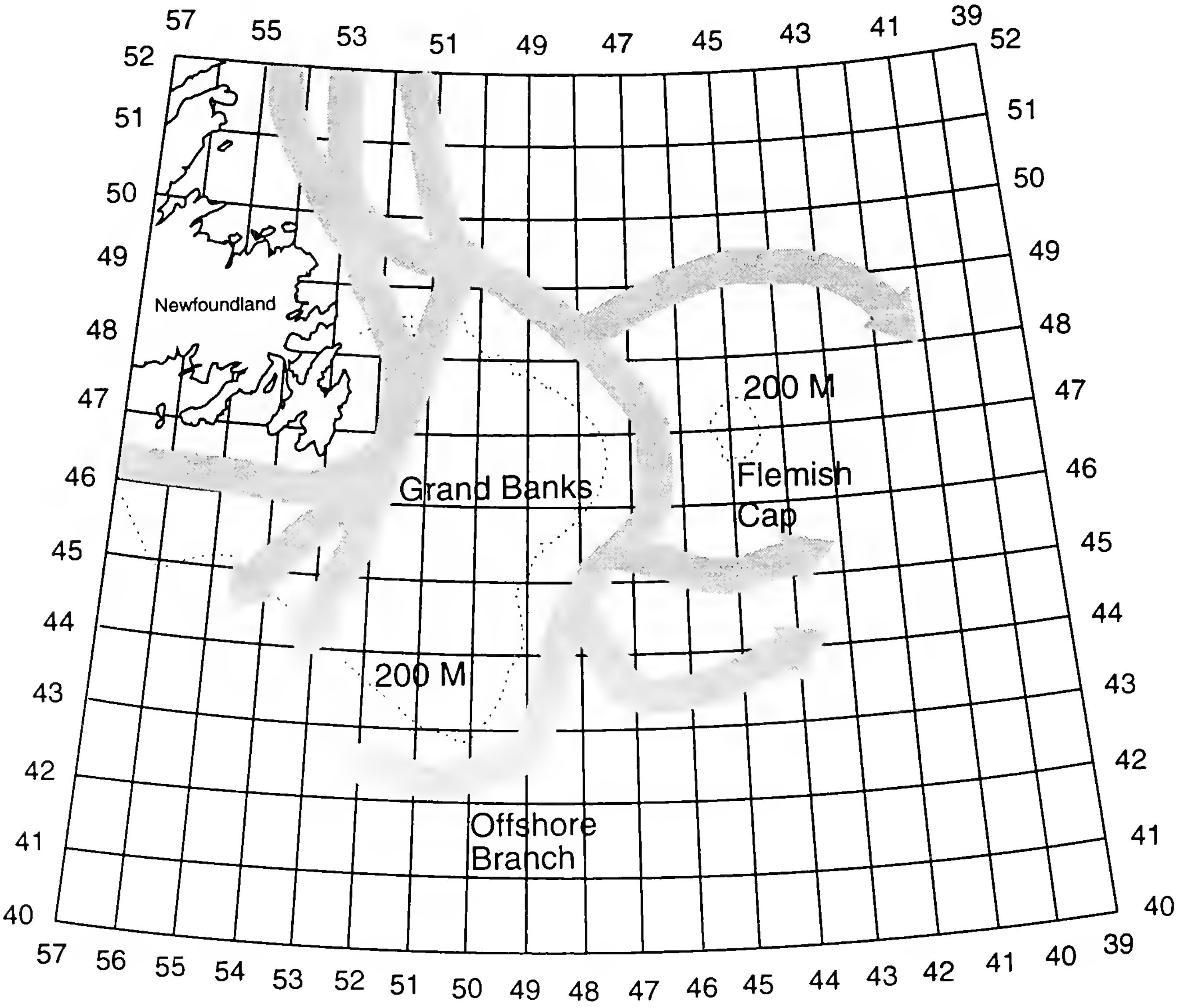


Figure 2
The Labrador Current, the main mechanism for transporting icebergs South to the Grand Banks

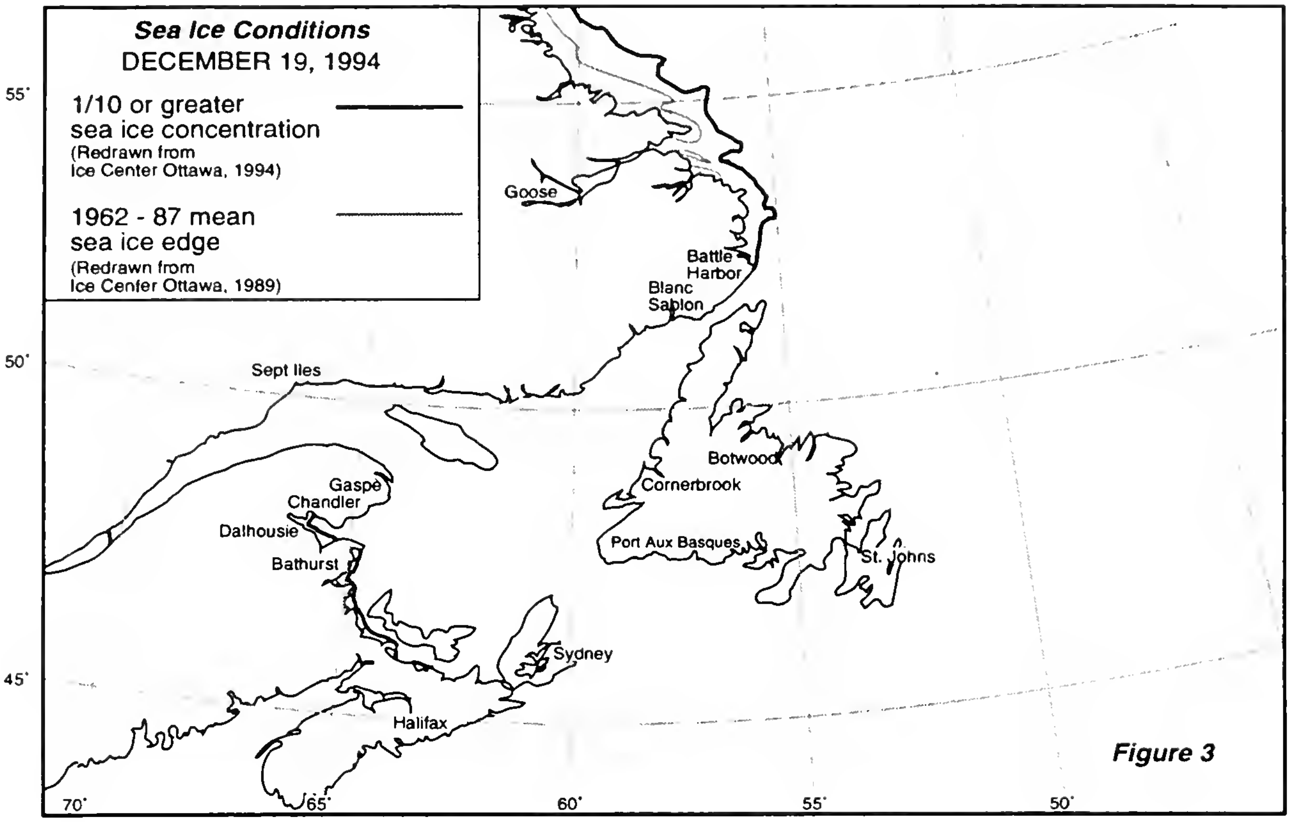


Figure 3

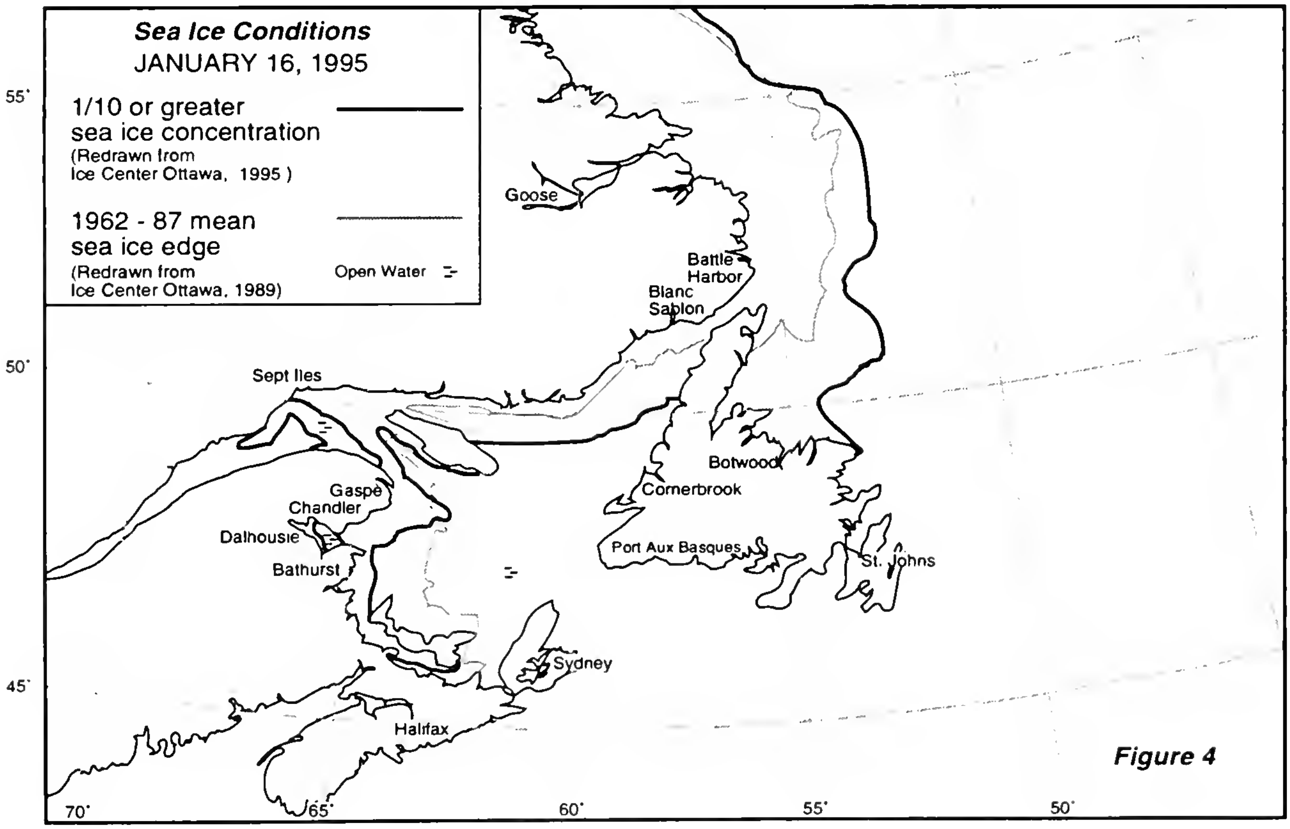


Figure 4

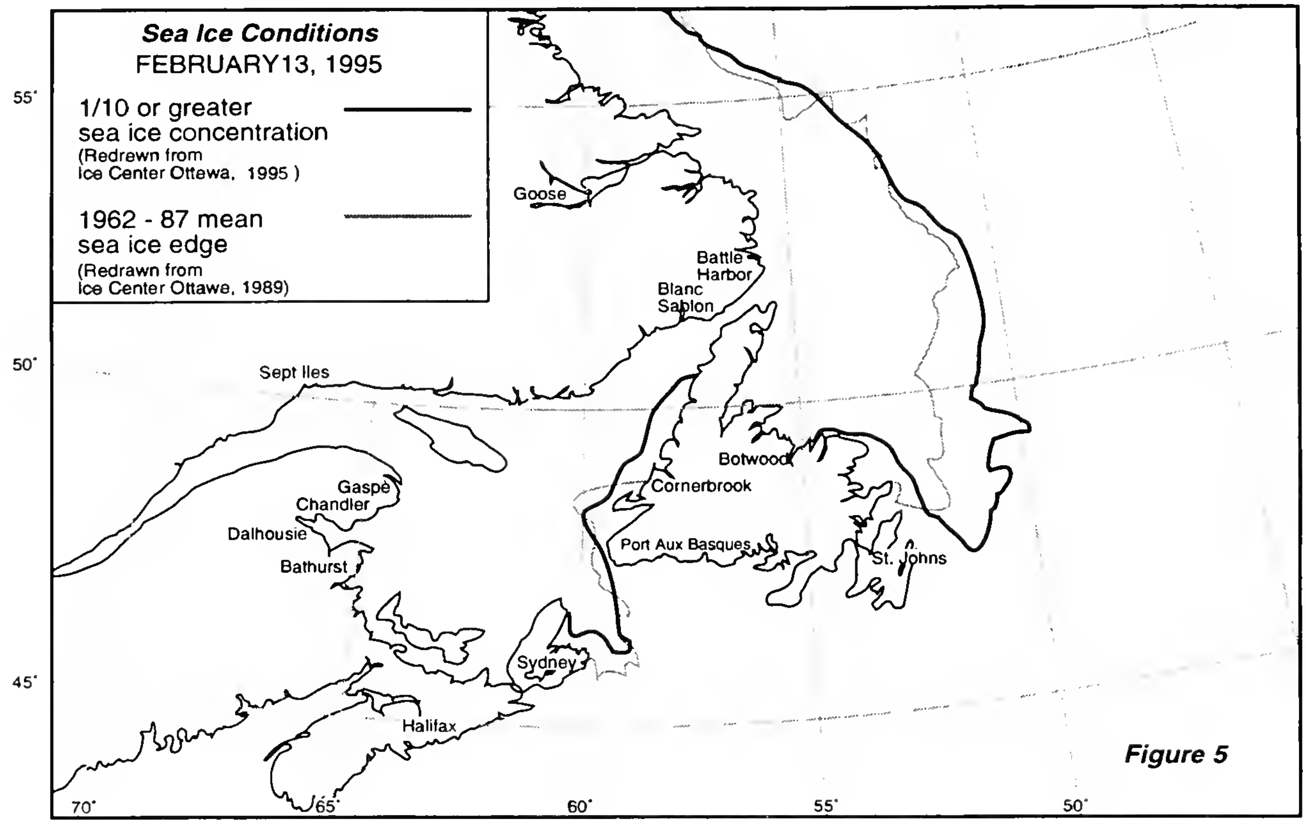


Figure 5

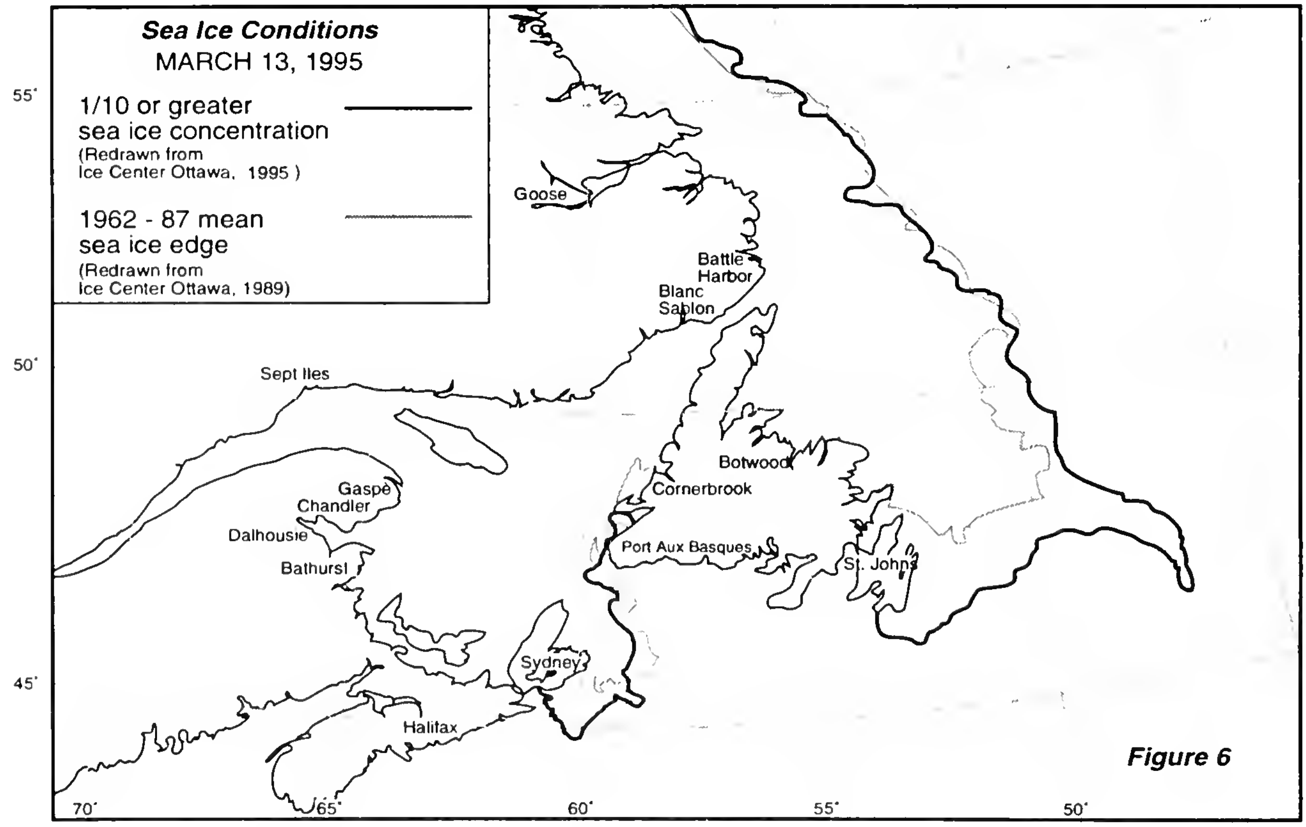


Figure 6

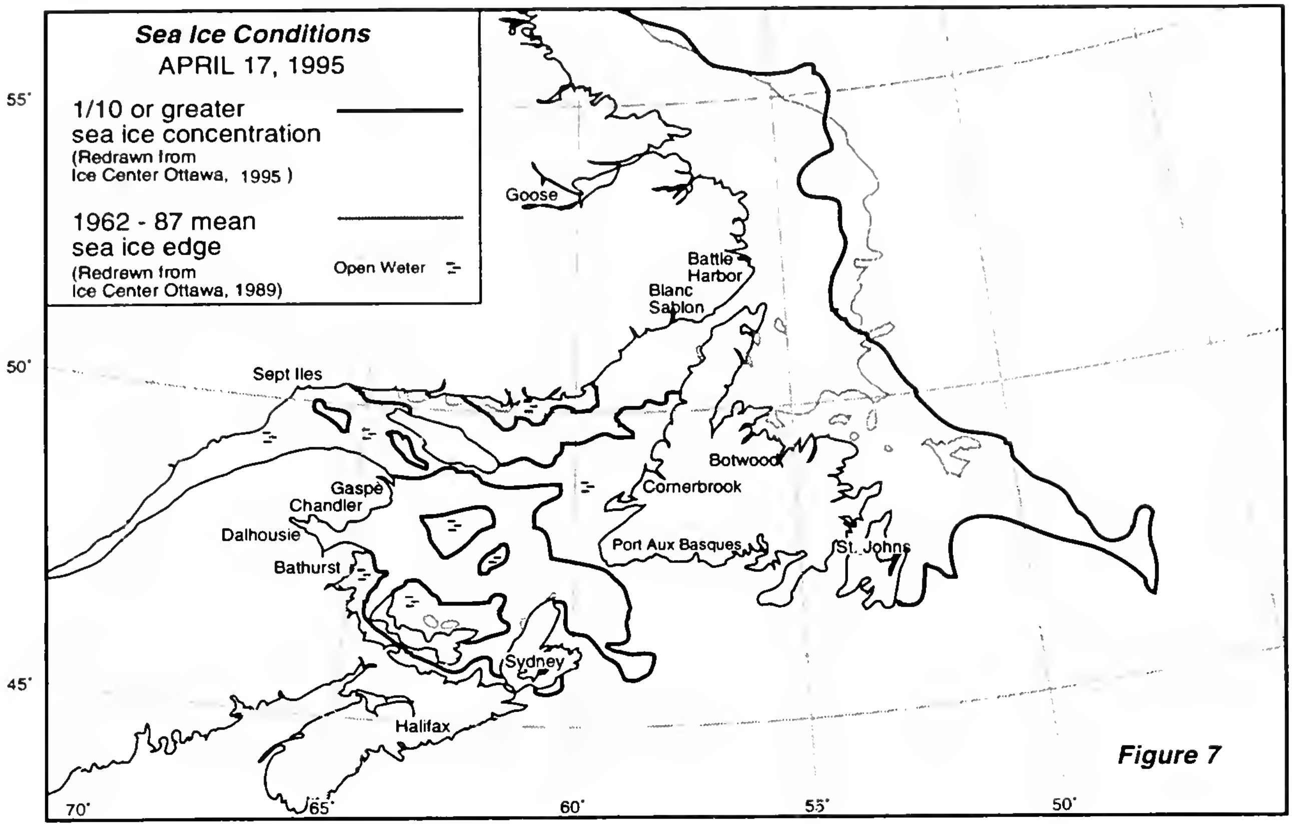


Figure 7

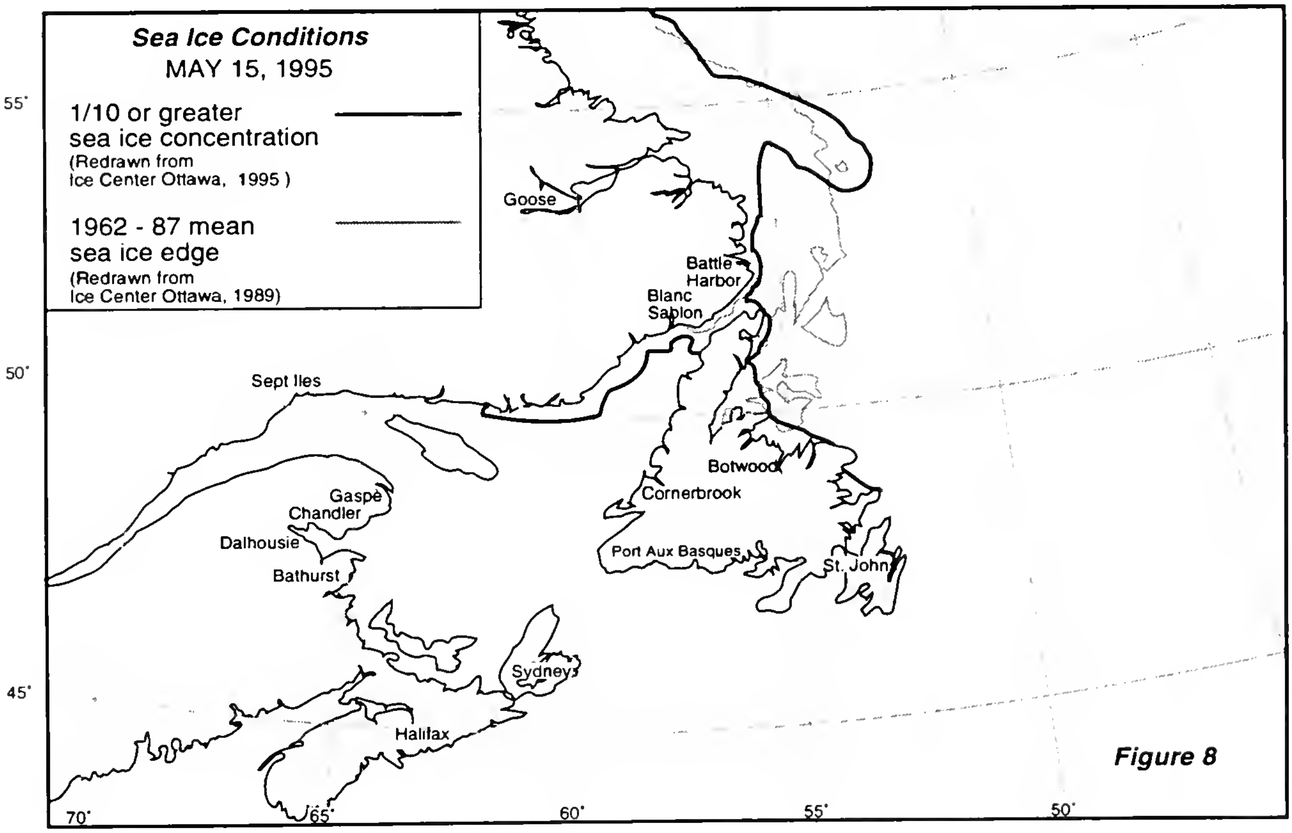
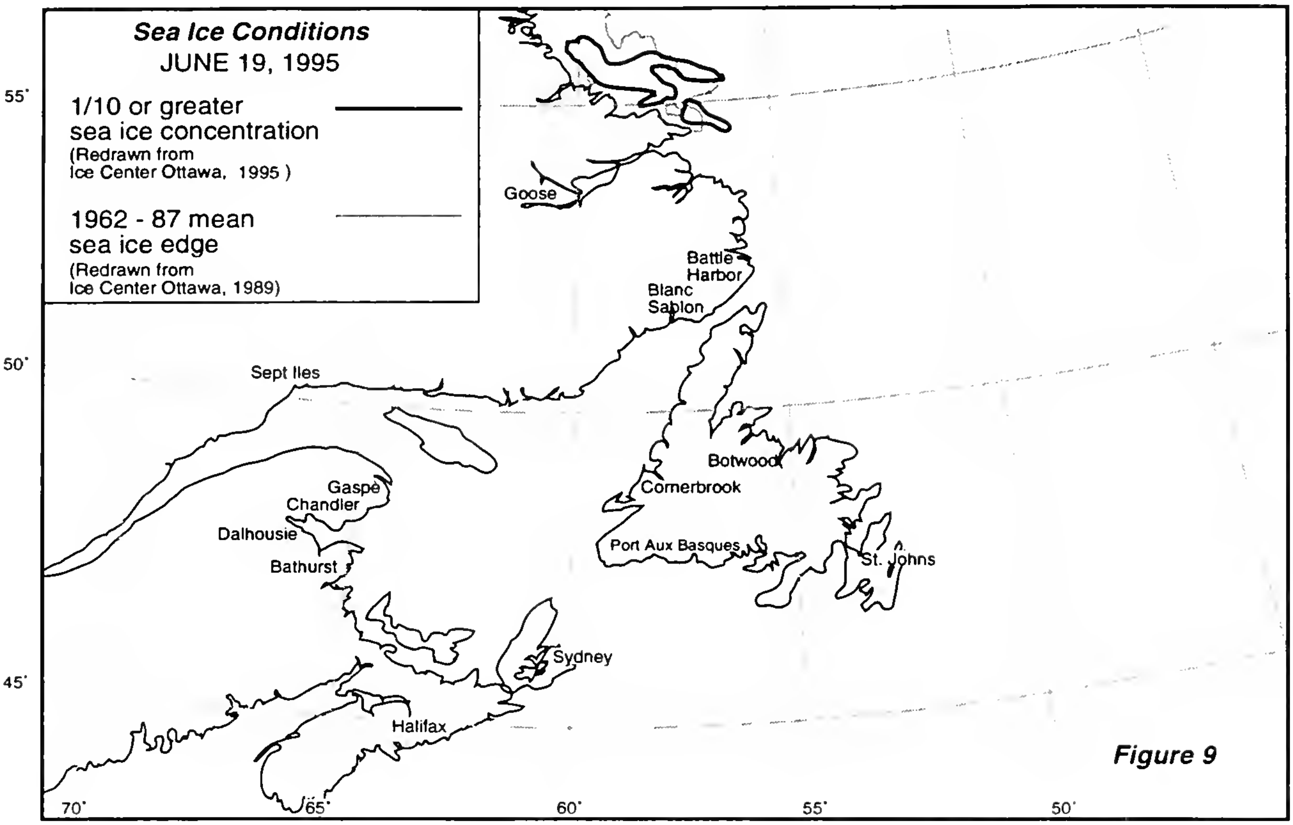


Figure 8



Sea Ice Conditions
JUNE 19, 1995
1/10 or greater sea ice concentration
(Redrawn from Ice Center Ottawa, 1995)
1962 - 87 mean sea ice edge
(Redrawn from Ice Center Ottawa, 1989)
55°
50°
45°
70°
65°
60°
55°
50°
Goose
Battle Harbor
Blanc Sablon
Sept Iles
Botwood
Cornerbrook
Gaspé
Chandler
Dalhousie
Bathurst
Port Aux Basques
St. Johns
Sydney
Halifax

Figure 9

Figure 10

International Ice Patrol Plot for **0000 GMT 28 Feb 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

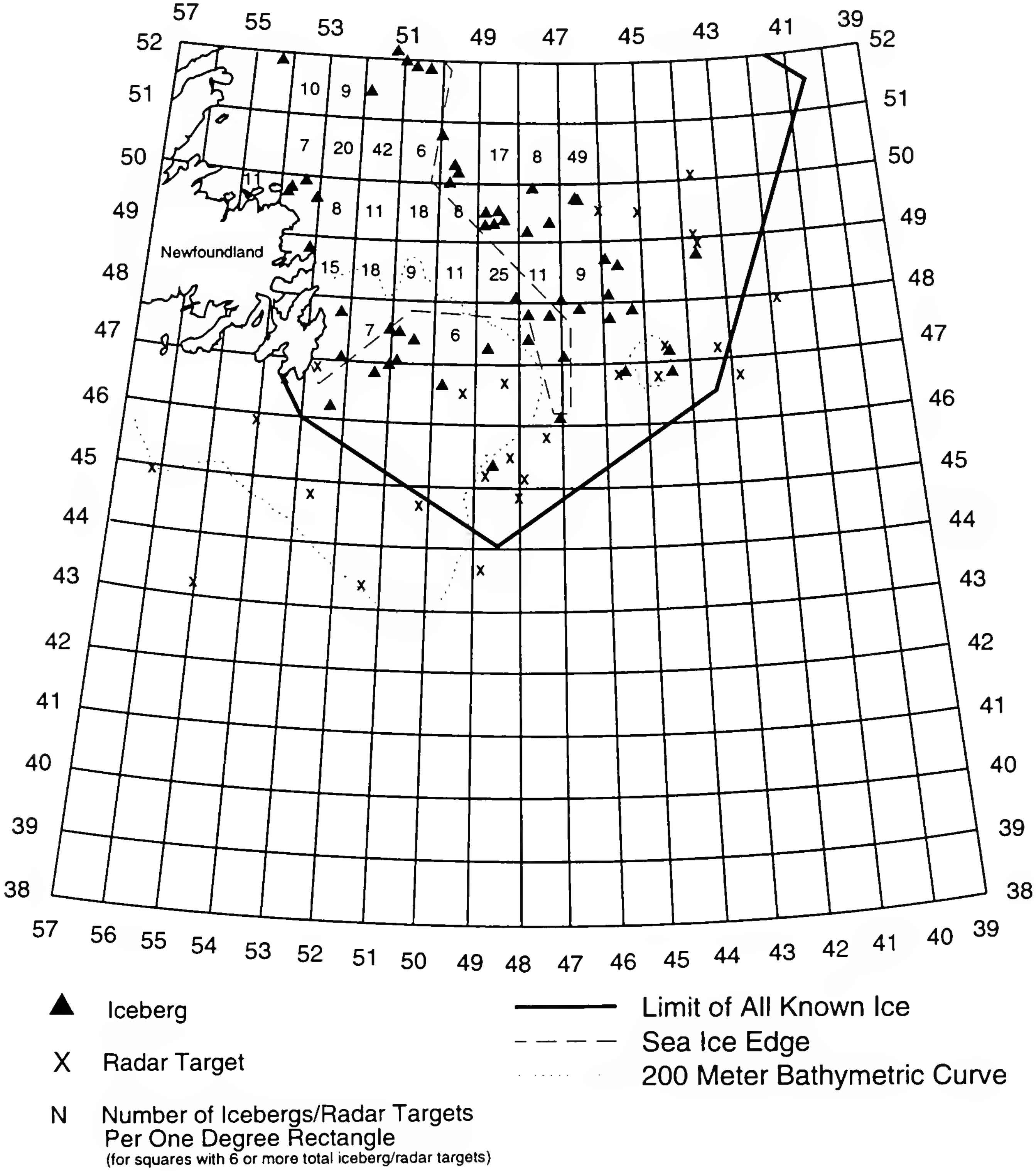
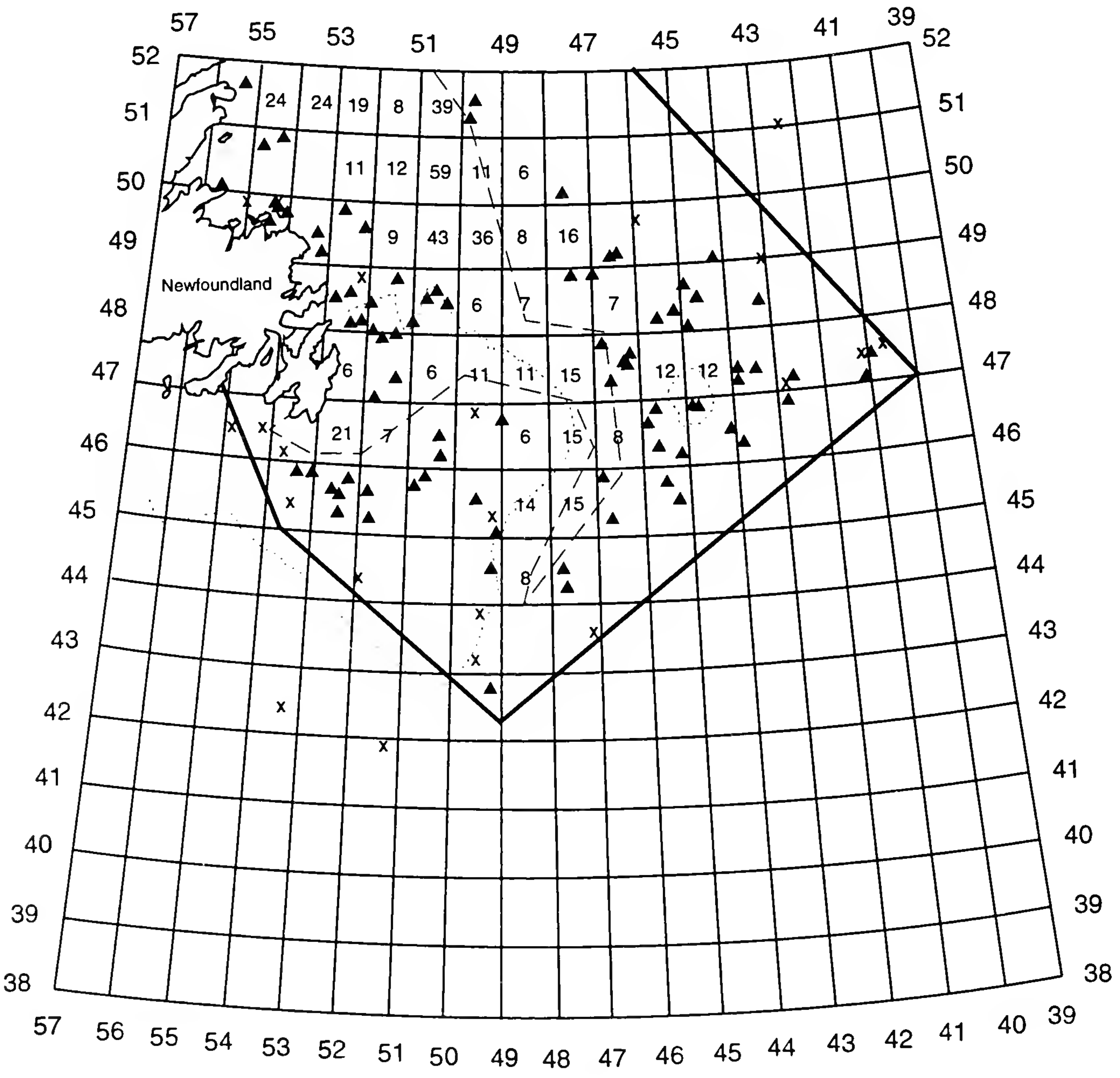


Figure 11
International Ice Patrol Plot for **0000 GMT 15 Mar 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge



▲ Iceberg

X Radar Target

N Number of Icebergs/Radar Targets Per One Degree Rectangle
(for squares with 6 or more total iceberg/radar targets)

Limit of All Known Ice

Sea Ice Edge

200 Meter Bathymetric Curve

Figure 12
International Ice Patrol Plot for **0000 GMT 31 Mar 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

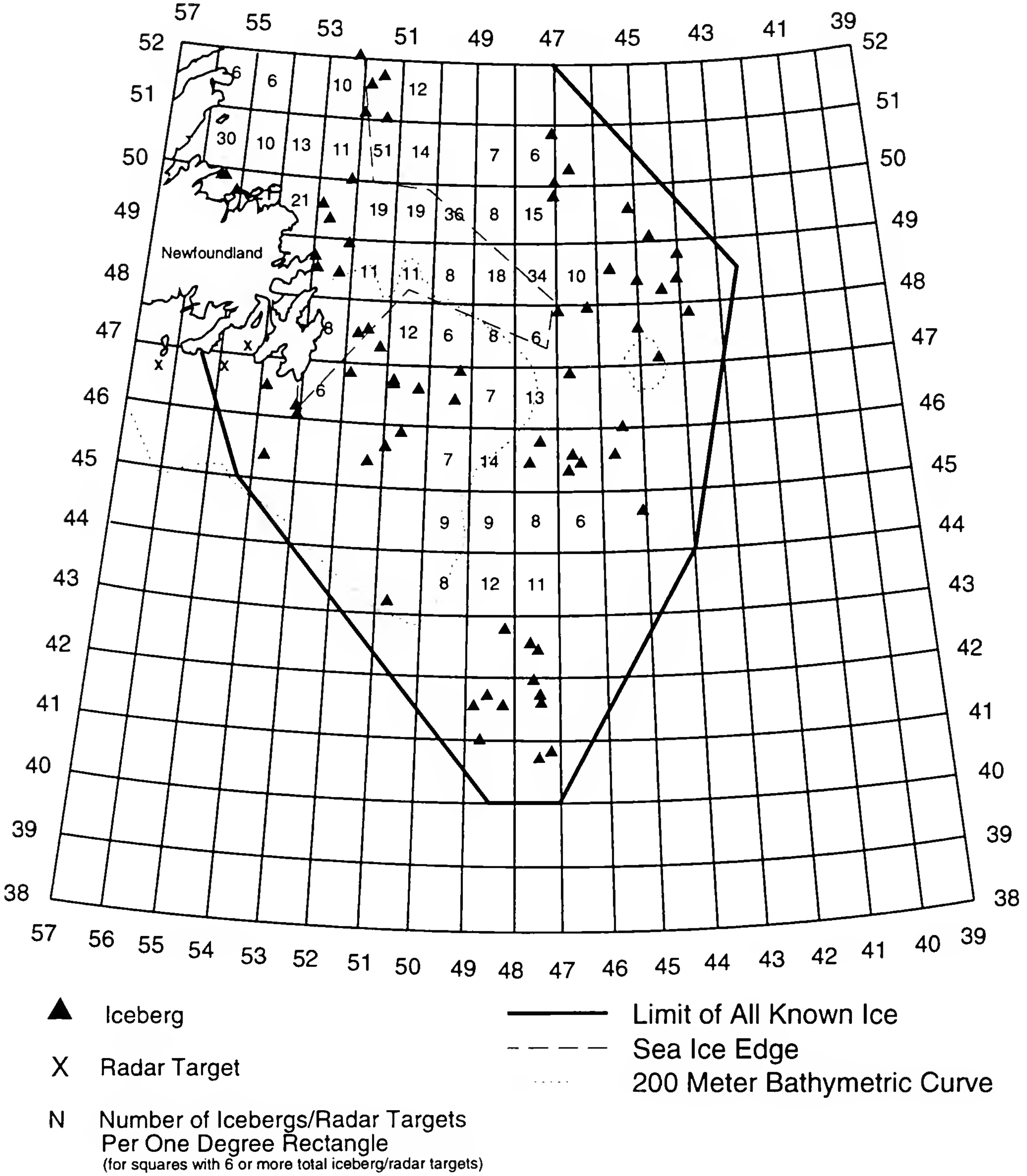


Figure 13
International Ice Patrol Plot for **0000 GMT 15 Apr 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

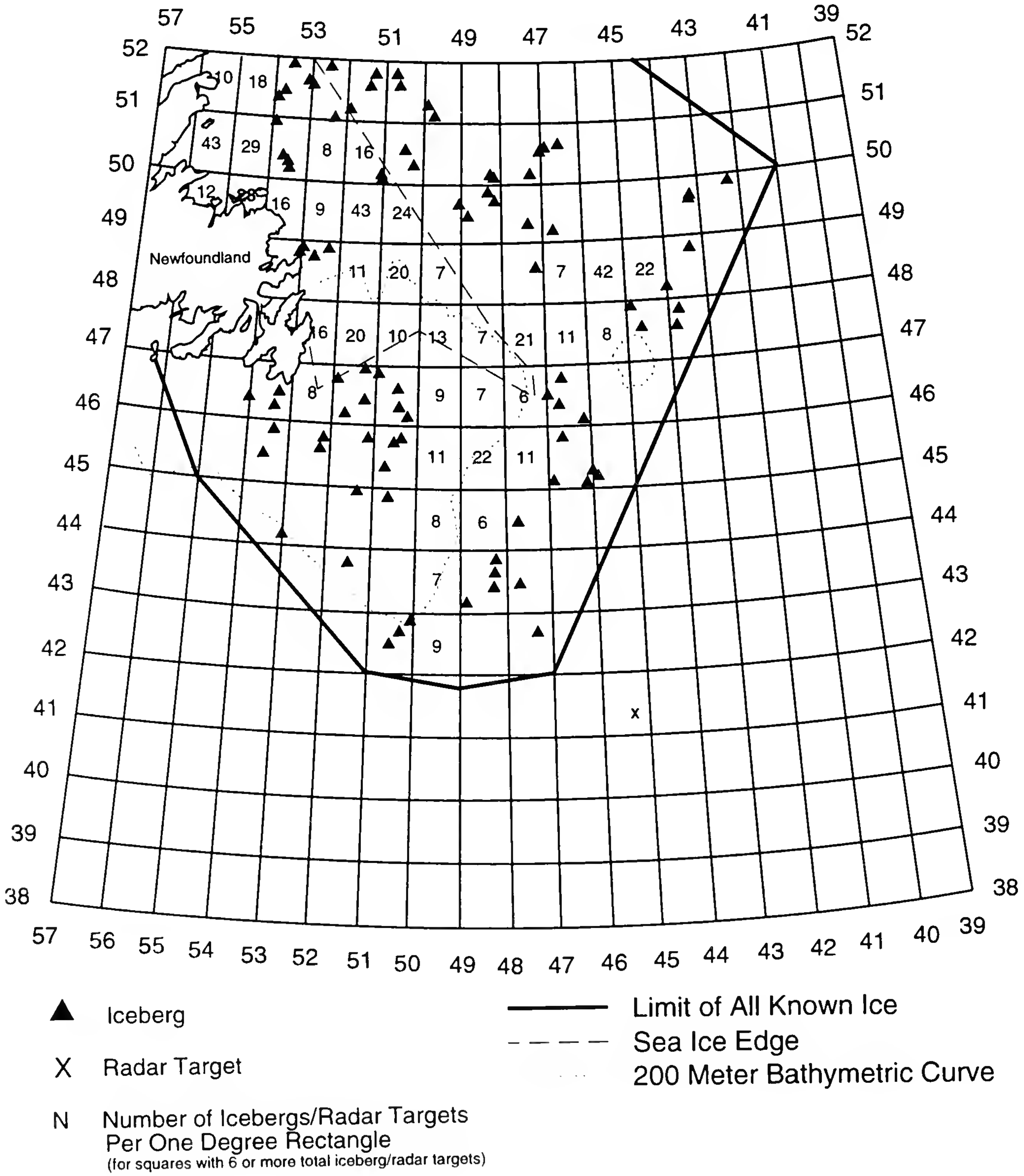


Figure 14

International Ice Patrol Plot for **0000 GMT 30 Apr 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

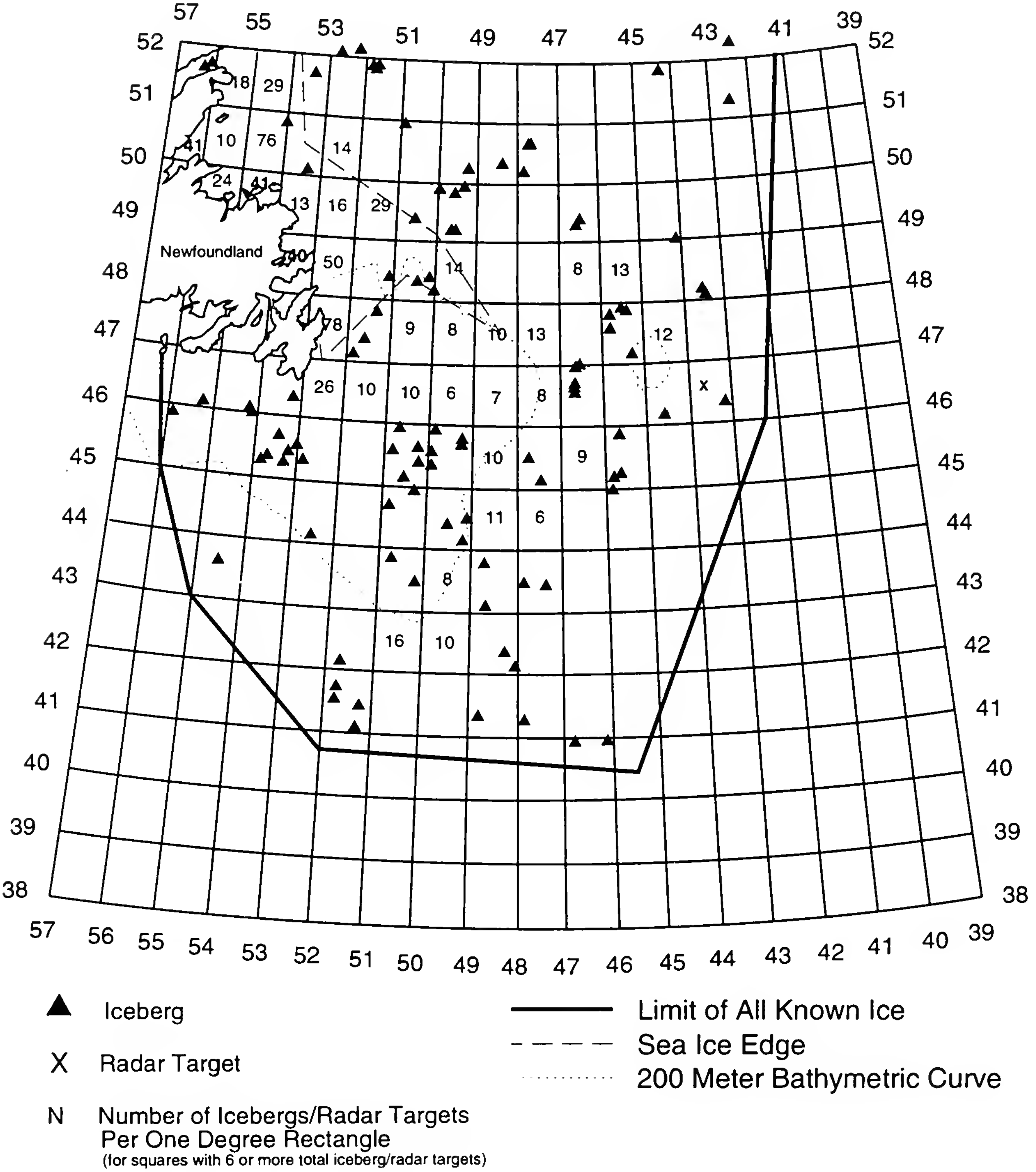


Figure 15
International Ice Patrol Plot for **0000 GMT 15 May 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

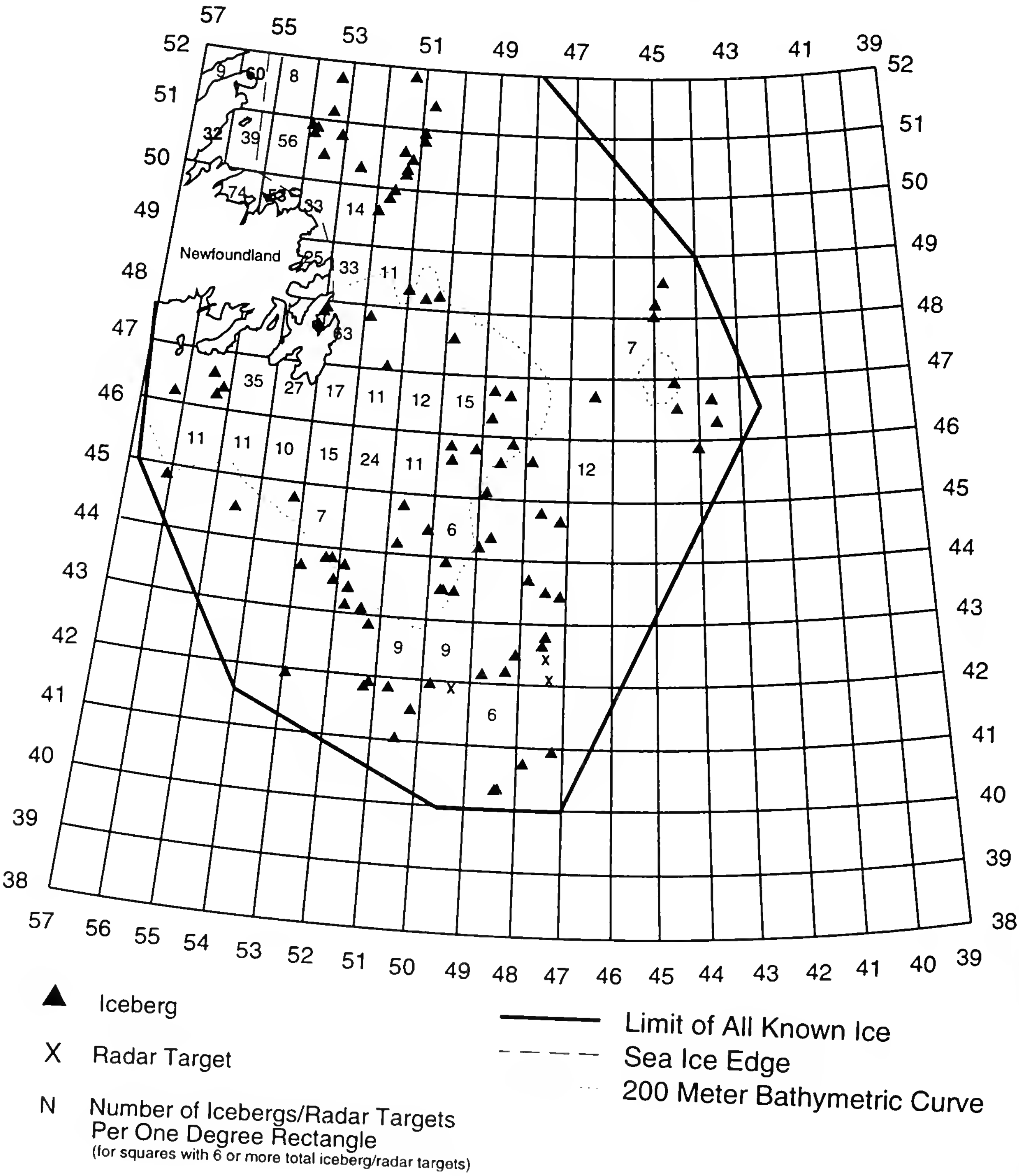
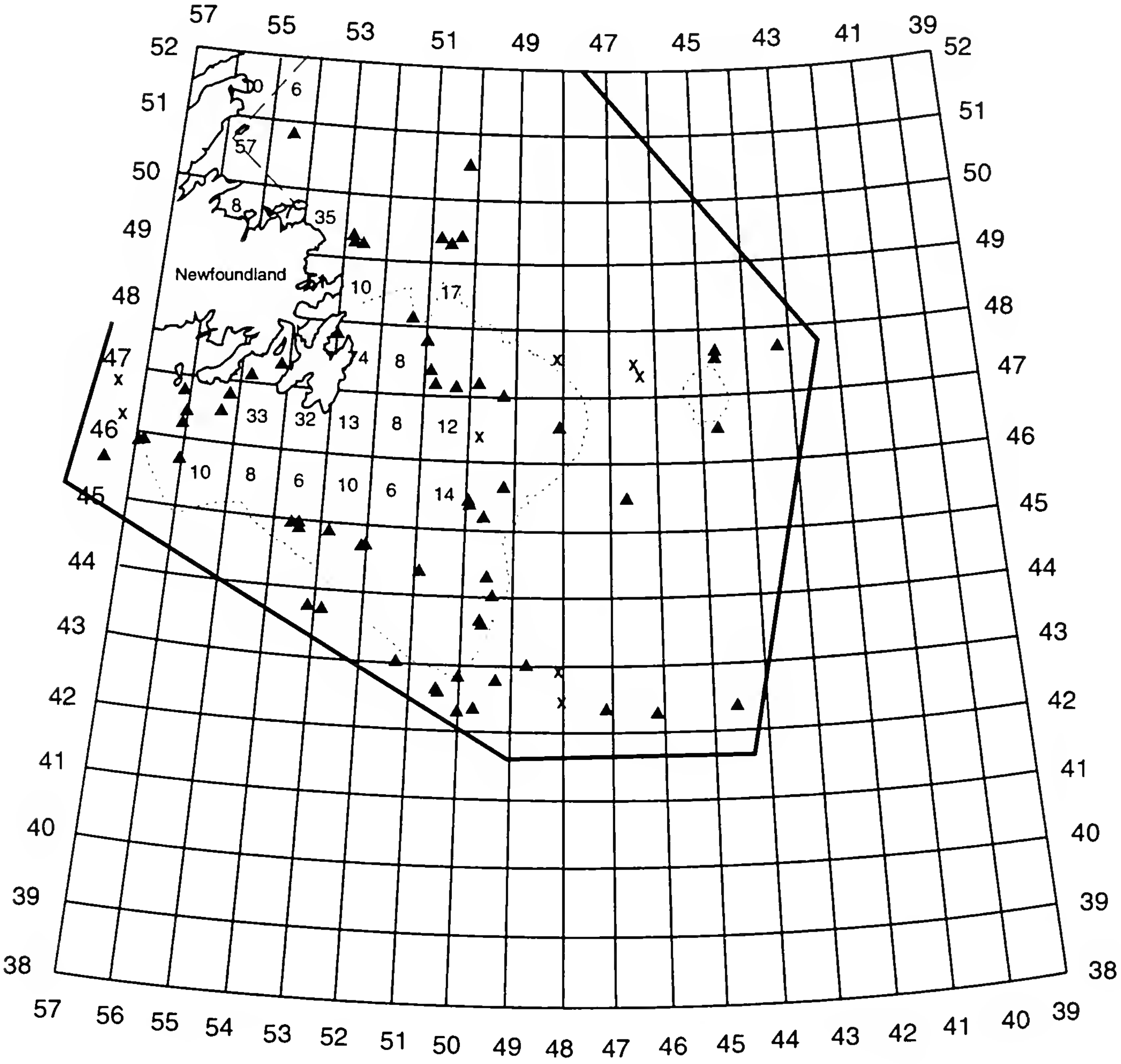


Figure 16
International Ice Patrol Plot for **0000 GMT 31 May 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge



▲ Iceberg

X Radar Target

N Number of Icebergs/Radar Targets Per One Degree Rectangle
(for squares with 6 or more total iceberg/radar targets)

Limit of All Known Ice

Sea Ice Edge

200 Meter Bathymetric Curve

Figure 17

International Ice Patrol Plot for **0000 GMT 15 Jun 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

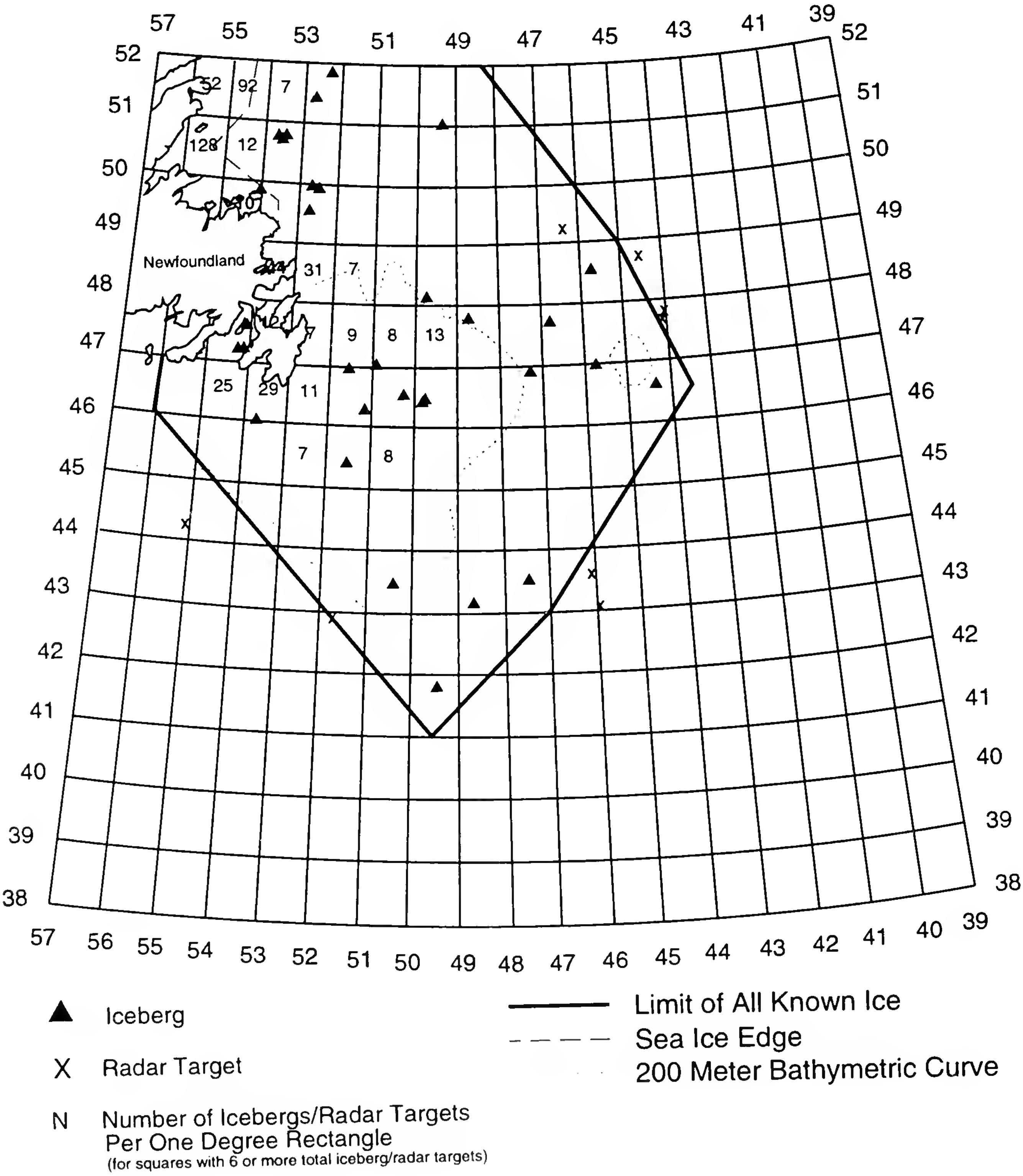


Figure 18
International Ice Patrol Plot for **0000 GMT 30 Jun 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge

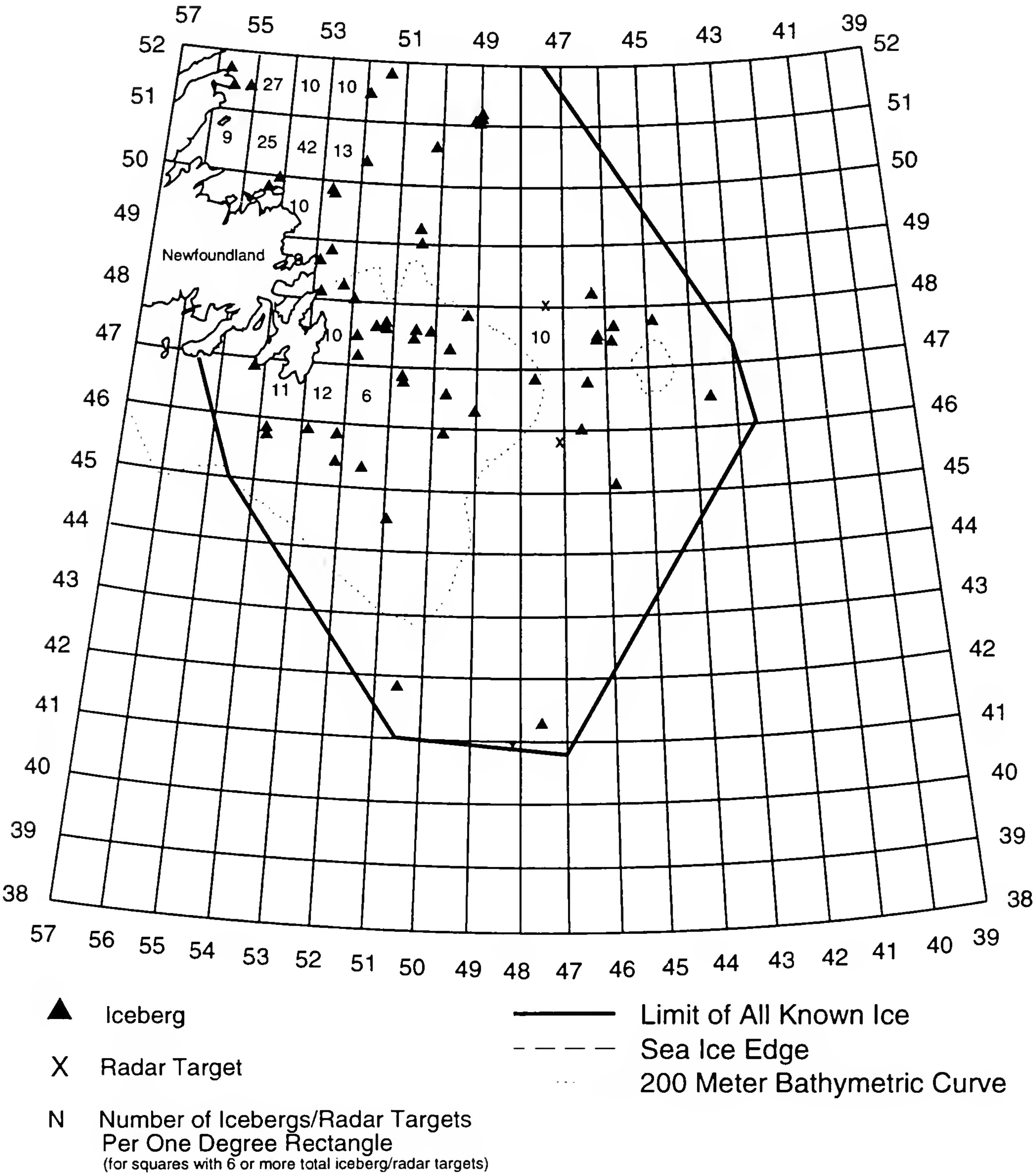
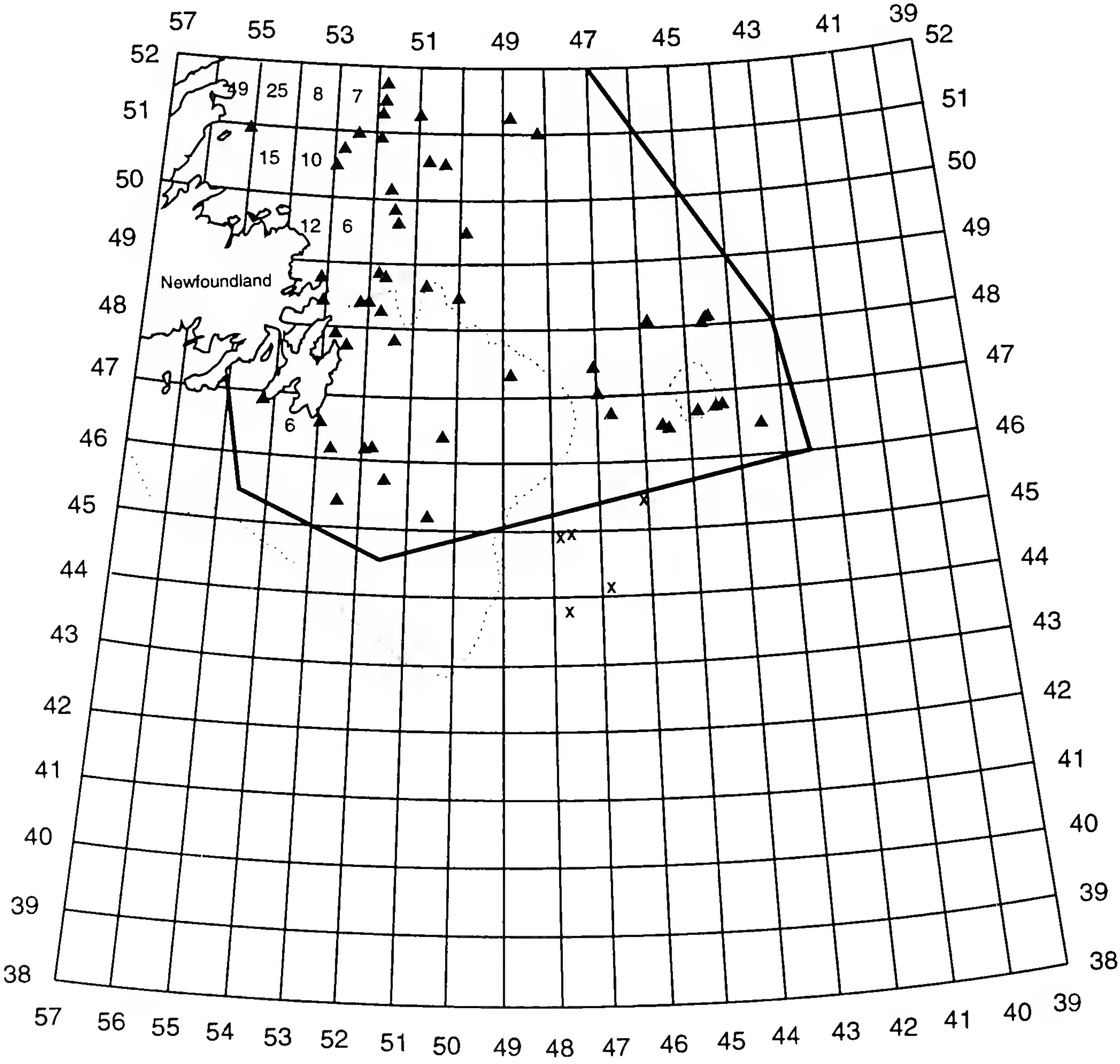


Figure 19
International Ice Patrol Plot for **0000 GMT 15 Jul 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge



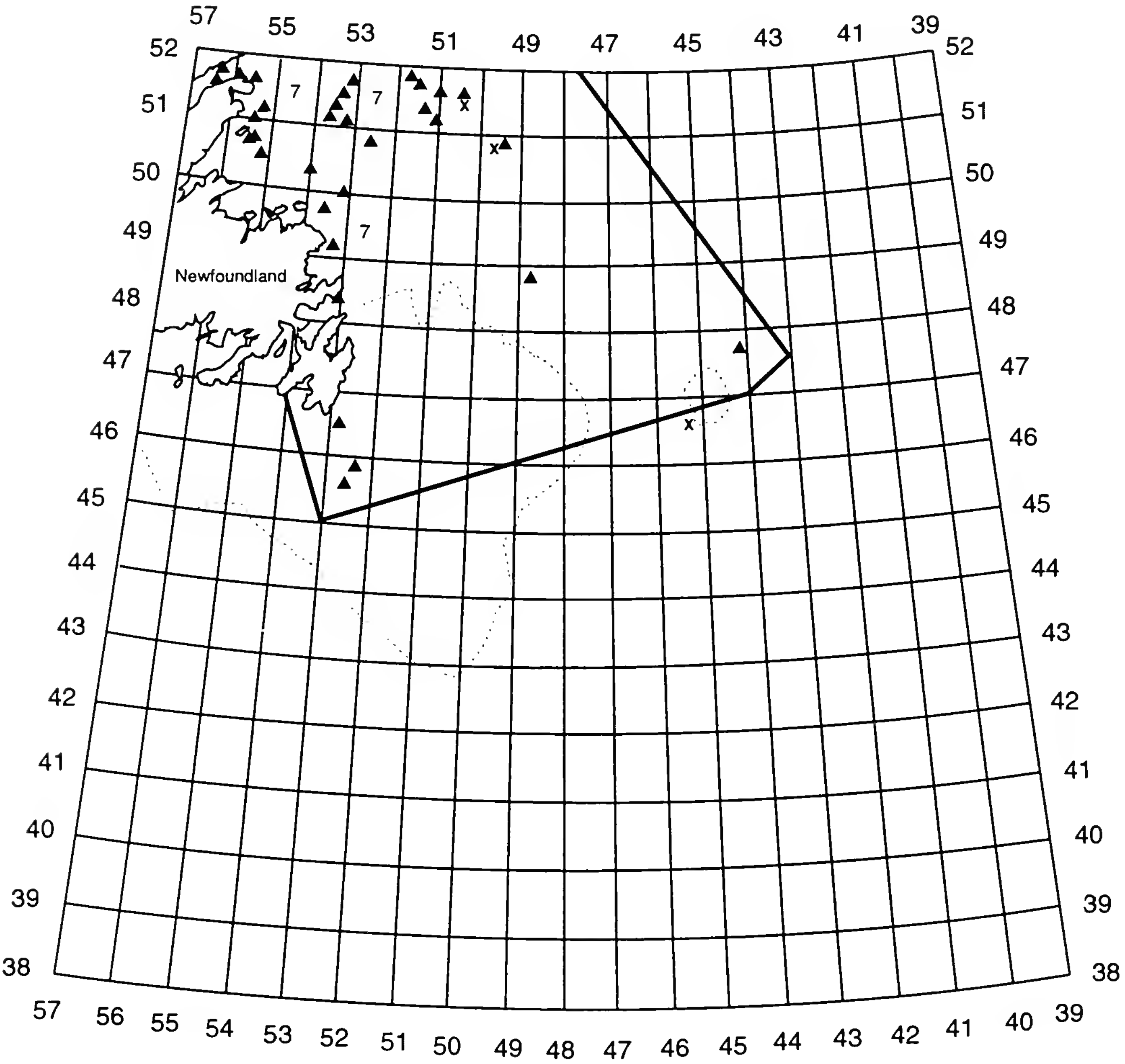
▲ Iceberg

X Radar Target

N Number of Icebergs/Radar Targets
Per One Degree Rectangle
(for squares with 6 or more total iceberg/radar targets)

—— Limit of All Known Ice
– – – – Sea Ice Edge
· · 200 Meter Bathymetric Curve

Figure 20
International Ice Patrol Plot for **0000 GMT 31 Jul 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge



▲ Iceberg

X Radar Target

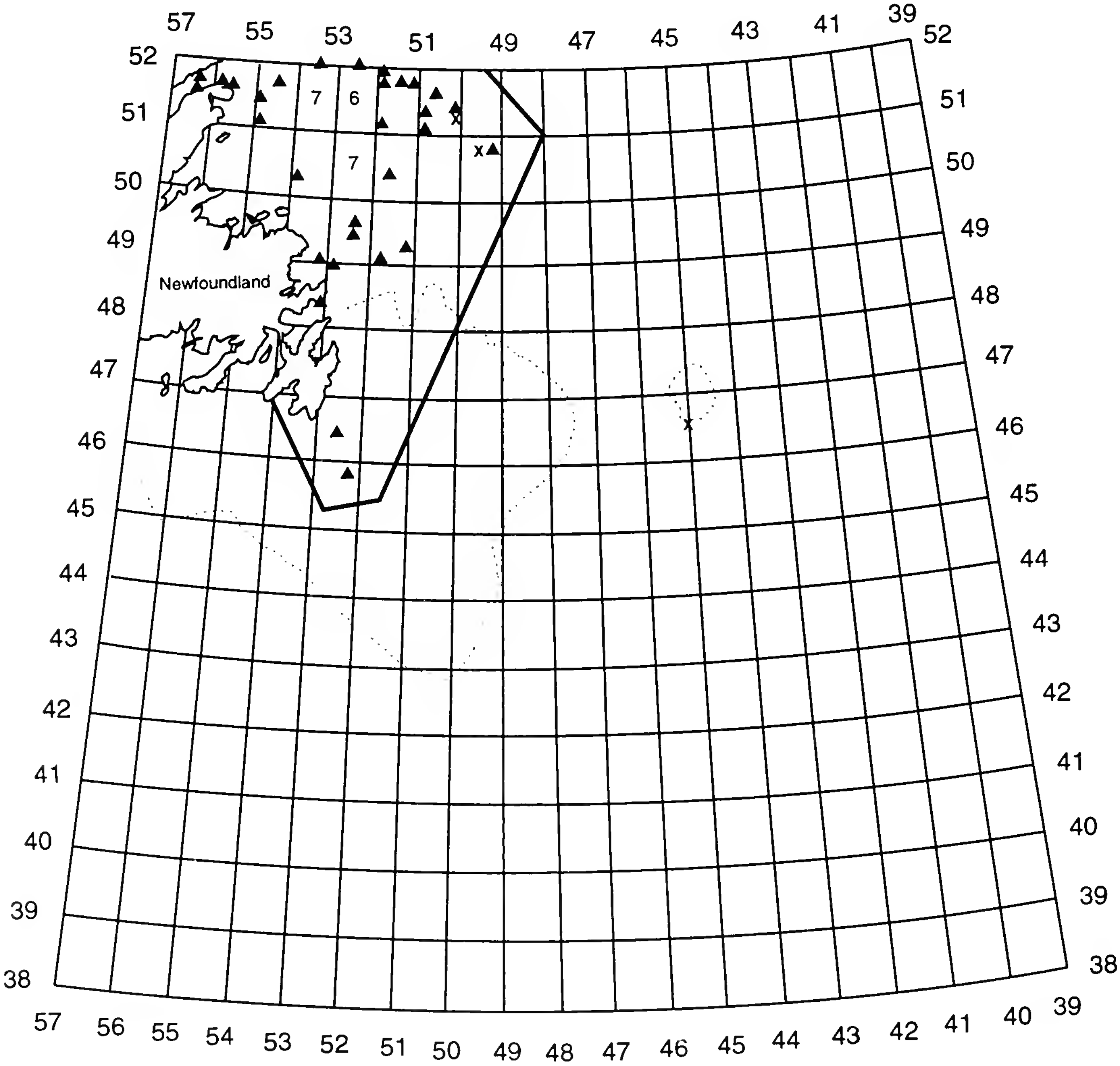
N Number of Icebergs/Radar Targets Per One Degree Rectangle (for squares with 6 or more total iceberg/radar targets)

—— Limit of All Known Ice

– – – – Sea Ice Edge

· · · · 200 Meter Bathymetric Curve

Figure 21
International Ice Patrol Plot for **1200 GMT 01 Aug 95**
Showing Observed and Modeled Iceberg
Positions and Sea Ice Edge



▲ Iceberg

X Radar Target

N Number of Icebergs/Radar Targets Per One Degree Rectangle
(for squares with 6 or more total iceberg/radar targets)

——— Limit of All Known Ice

– – – – Sea Ice Edge

. . . 200 Meter Bathymetric Curve

Acknowledgments

Commander, International Ice Patrol acknowledges the assistance and information provided by:

Atmospheric Environment Service of Environment Canada
Department of Fisheries and Oceans
Navy / NOAA / USCG Joint Ice Center
U.S. Naval Fleet Numerical Meteorological and Oceanography Center
U.S. Naval Atlantic Meteorology and Oceanography Center
U.S. Coast Guard Research and Development Center
Coast Guard Atlantic Area Staff
First Coast Guard District Communications Center
First Coast Guard District Operations Center

We extend our sincere appreciation to the staffs of these organizations for their excellent support during the 1995 International Ice Patrol season:

Canadian Coast Guard Radio Station St. John's, Newfoundland/VON
Ice Operations St. John's, Newfoundland
Air Traffic Control Gander, Newfoundland
Canadian Forces Gander and St. John's, Newfoundland
St. John's Flight Services Office
U.S. Coast Guard Air Station Elizabeth City, North Carolina
National Meteorological Center, Maryland

It is also important to recognize the outstanding efforts of the personnel at the International Ice Patrol:

CDR R. L. Tuxhorn
CDR B. E. Viekman
Dr. D. L. Murphy
Mr. G. F. Wright
LT G. A. Trivers
LT R. T. Haines
MSTC J. F. Fisher
YN1 C. B. Peters
MST1 D. L. Alexander
MST1 V. L. Fogt
MST1 R. A. McKnight
MST2 C. L. Channel
MST2 W. S. Barton
MST2 J. F. Cole
MST2 E. M. Fusco
MST3 J. T. Sobiesczyk
MST3 B. B. Keating
MST3 M. L. McClain
MST3 T. T. Krein

This report was produced using Adobe Illustrator™ V4 and Adobe™ Pagemaker™ V5 for Windows® by MST3 Bruce B. Keating and LT Robert T. Haines.

Appendix A
Nations Currently Supporting International Ice Patrol

BELGIUM	*NORWAY*
CANADA	*PANAMA*
DENMARK	*POLAND*
FINLAND	*SPAIN*
FRANCE	*SWEDEN*
GREECE	*UNITED KINGDOM*
ITALY	*UNITED STATES*
JAPAN	*GERMANY*
NETHERLANDS	

Appendix B
Ship Reports

Ship Name	Ship Flag	Ice Report	SST* Report
ABBEY	CAYMAN ISLANDS	1	
ABITIBI CLAIBORNE	GERMANY	1	
ABITIBI CONCORD	LIBERIA	1	
ABITIBI MACADO	LIBERIA	1	
ABITIBI ORINOCO	GERMANY	1	
ACHILLES	PANAMA	1	
ADA GORTHON	SWEDEN	5	
AG FARQUARSON	UNITED STATES	2	
AGIODEKTINI	GREECE	3	
AIVIK	CANADA	4	
ALAM ACAPULCO	MALAYSIA	1	
ALAM SENANG	MALAYSIA	8	
ALEKSANDER KOLMPERE	ESTONIA	4	8
ALEXIS	MALTA	1	
ALLOUETTE ARROW	NORWAY	4	
ALPHA	LIBERIA	1	
AMKE	GERMANY	2	
ANATOLI	MALTA	1	
ANEMI	GREECE	1	
ANN HARVEY	CANADA	1	
APJ ANJLI	INDIA	1	1
APOLLONIA LION	GREECE	1	
AQUARIUS	ITALY	1	
AROSA	CYPRUS	1	
ARCADIA I	PANAMA	2	
ARCTIC	CANADA	12	
ARGOSY	INDIA	1	
ARINA ARCTICA	DENMARK	2	
ARMIA LUDOWA	POLAND	1	
ASL SANDERLING	CANADA	1	
ATALAYA	UNITED STATES	1	
ATLANTA FOREST	CANADA	1	
ATLANTIC CLIPPER	PANAMA	47	
ATLANTIC COMPANION	SWEDEN	1	
ATLANTIC CONVEYER	UNITED KINGDOM	1	
ATLANTIC ODYSSEY	CANADA	1	
ATLANTIC TRIDENT	CYPRUS	3	
ATLANTIS SPIRIT	CYPRUS	1	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
ATLANT 1	BAHAMAS	16	31
ATLANT 2	MALTA	26	44
BAIA DE CRIS	RUMANIA	1	4
BAKENGRACHT	NETHERLANDS	2	
BAKKAFOSS	ANTIGUA/BARBUDA	3	
BALLERINA	NORWAY	1	
BARBRO	SINGAPORE	2	
BERGE FISTER	NORWAY	1	
BERGEN SEA	NORWAY	1	
BERGON	SWEDEN	11	
BILICE	MALTA	3	
BOW HUNTER	NORWAY	1	
BRANDENBERG	GERMANY	5	
BRIGIT MAERSK	DENMARK	1	
BRISTER	UNKNOWN	1	
BRITISH STEEL	HONG KONG	7	27
BROUWERGRACHT	NETHERLANDS	1	
BRUM LES	UNKNOWN	1	
BURUM LES	UNKNOWN	1	
CAMILLA	FINLAND	38	
CANMAR CONQUEST	UNITED KINGDOM	13	
CANMAR ENTERPRISE	BAHAMAS	1	
CANMAR EUROPE	BERMUDA	11	
CANMAR PRIDE	GREECE	2	
CANMAR GLORY	BERMUDA	6	
CANMAR INTREPID	UNKNOWN	1	
CANMAR TRIUMPH	UNITED KINGDOM	14	
CANMAR VALIANT	CROATIA	2	
CANMAR VICTORY	UNITED KINGDOM	9	
CAPE ROGER	CANADA	1	
CAPE VIOLET	PANAMA	1	1
CAROLA 1	CYPRUS	4	
CASTILLO DE AREVALO	BAHAMAS	1	
CAST BEAR	UNKNOWN	5	
CAST BEAVER	CROATIA	10	17
CAST ELK	SINGAPORE	2	
CAST LYNX	UNKNOWN	3	
CAST POLAR BEAR	BAHAMAS	6	
CAST WOLF	SINGAPORE	2	
CECILIA DESGAGNES	CANADA	2	
CETRA CANADA	CANADA	1	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
CETRA CORONA	CANADA	1	4
CHALLENGER PATROL	UNKNOWN	2	
CHANNEL PROSPERITY	PHILLIPINES	1	2
CHEBUCTO SEA	CANADA	1	
CICERO	CANADA	3	
COLUMBIA	VANUATU	1	
COMPANION EXPRESS	SWEDEN	2	1
CONTICARIB	CYPRUS	1	
CONCORDIA	NORWAY	3	
CORNELIS VEROLME	LUXUMBERG	1	
CORNER BROOK	SWEDEN	1	
CRYSTAL HARMONY	BAHAMAS	1	
CSS HUDSON	CANADA	1	
CYGNUS	CANADA	1	
DAGEID	BAHAMAS	1	
DAGHILD	NORWAY	1	
DES GROSELLIERS	CANADA	3	
DMITRIY DONSKOY	RUSSIA	2	
DOBROTA	UNKNOWN	1	
DOMODYEDOVO	RUSSIA	1	
DONAU ORE	CHINA	6	
DUBROVNIK	MALTA	1	
EDWARD CORNWALLIS	CANADA	3	
ELLISPONTOS	CYPRUS	5	3
EMERALD STAR	CANADA	2	
EMIL S	CYPRUS	1	
FAITH IV	SINGAPORE	1	5
FEDERAL AGNO	PHILIPPINES	2	
FEDERAL MACKENZIE	HONG KONG	1	
FEDERAL MANITOU	NORWAY	2	
FEDERAL MATANE	NORWAY	5	
FEDERAL POLARIS	LIBERIA	1	
FEDERAL SAGUENAY	LIBERIA	1	
FETISH	DENMARK	1	
FINNFIGHTER	BAHAMAS	15	
FIRST LADY	BAHAMAS	1	
FROTARGENTINA	BRAZIL	2	
FURUNES	PANAMA	1	
GENERAL CABAL	PHILIPPINES	2	
GENOVA	ITALY	5	
GOLDEN SHIELD	PANAMA	1	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
GRIZZLY	MALTA	1	
GROTON	UNITED STATES	2	
HARP	CANADA	1	
HASKERLAND	NETHERLANDS	2	
HELLENIC CONFIDENCE	CYPRUS	1	
HENRY LARSON	CANADA	3	
HERCEGOVINA	MALTA	1	
HMCS MORESBY	CANADA	3	26
HMCS PRESERVER	CANADA	1	
HOFSJOKULL	ICELAND	4	
HUDSON	CANADA	3	
HYPHESTOS	LIBERIA	1	
IMPERIAL ACADIA	CANADA	3	
INDEPENDANT PIONEER	GERMANY	1	
INGRID GORTHON	SWEDEN	1	
IRA	LIBERIA	1	
IRVING ARCTIC	CANADA	1	
IRVING ESKIMO	CANADA	11	
ISLAND GEM	GREECE	4	
ISLAND SKIPPER	GREECE	1	
IVANUATU DERBENYEV	RUSSIA	2	
IVORY	CYPRUS		
J.C. PHILLIPS	CANADA	5	
J.E. BERNIER	CANADA	1	
JEAN LYKES	UNITED STATES	1	
JERRY NEWBERRY	CANADA	1	
JIM KILABUK	CANADA	1	
JON GORTHON	SWEDEN	1	
KAWA	BAHAMAS	1	
KAPITAN STANKOV	RUSSIA	1	
KAPITONAS A LUCKA	RUSSIA	1	18
KAPITONAS GUDIN	RUSSIA	10	
KAPITONAS MESCERIAKOV	LITHUANIA	1	
KAPITONAS REUTOV	LITHUANIA	8	
KAPITONAS VAVILOV	RUSSIA	4	
KARINA DANICA	DENMARK	1	1
KINGUK	CANADA	1	
KIROVOGRAD	UKRAINE	1	
KISTA ARCTICA	DENMARK	1	
KLYKACH	RUSSIA	2	
KNIEPSAND	CYPRUS	1	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
KOELN EXPRESS	SINGAPORE	1	
LA BRIANTAIS	FR. ANTARCTIC TERR.	14	13
LA SALLE I	UNKNOWN	1	
LACKENBY	BAHAMAS	1	
LAKE CARLING	UNITED STATES	4	
LAKE CHAMPLAIN	PANAMA	9	
LAKE ERIE	MALAYSIA	14	23
LAKE MICHIGAN	MALAYSIA	2	
LARINA	NORWAY	8	
LAS BOLINAS	CANADA	3	
LASISA	LITHUANIA	2	
LAURA HELENA	CYPRUS	3	
LE CHENE	CANADA	1	
LE SAULE NO. 1	CANADA	2	
LET KIEVU	UNKNOWN	2	
LIVEZENI	RUMANIA	1	
LOTILA	FINLAND	1	3
LOUIS ST LAURENT	CANADA	1	
LUCKY SAILOR	MALTA	1	
LUYBLINO	UNKNOWN	2	
M. HASS	BAHAMAS	3	
MADREDEUS	CYPRUS	1	
MAERSK HOUSTON	GREECE	1	
MALIK II	VANUATU	5	2
MARGIT GORTHON	SWEDEN	4	
MARIA	NORWAY	2	
MARINE HAWK	DENMARK	1	
MARSHAL ROKOSSOVSKIY	RUSSIA	1	
MASS WIT	UNKNOWN	1	
MATA K	CYPRUS	3	
MEDALLION	DENMARK	5	
MERCY VENTURE	CANADA	2	
METTE MAERSK	DENMARK	1	
MICHAEL J	UNITED STATES	1	
MIGHTY SERVANUATUT	NETHERLANDS	3	
MISS JACQUELINE IV	CANADA	1	
MISTY WAVE	UNKNOWN	1	
MONTEREY	GREECE	1	
MONTREAL SENATOR	CANADA	1	
MOR CANADA	CYPRUS	2	
MOR EUROPE	CYPRUS	2	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
MOR U.K.	CYPRUS	2	
MSC SABRINA	PANAMA	1	2
NEPTUNE GARNET	SINGAPORE	1	
NANDU	LIBERIA	4	
NCC JIZAN	NORWAY	1	
NEDLLOYD HOORN	NETHERLANDS	1	
NORQUEST	BAHAMAS	1	
NORTHERN ENTERPRISE	BAHAMAS	1	
NORTHERN VOYAGER	UNITED STATES	1	
NORTHERN PRINCESS	CANADA	1	
NORTH MARCHIONESS	GREECE	6	
NOSAC TANABATA	LIBERIA	1	
OAK	BAHAMAS	1	6
OCEANBREEZE	UNITED STATES	1	
ODRANES	BAHAMAS	1	
OLYMPIC ARMOUR II	GREECE	10	
OMISALJ MAR	MALTA	1	
OOCL ASSURANCE	HONG KONG	18	
OOCL BRAVERY	HONG KONG	14	
ORAGREEN	BAHAMAS	1	
PALMGRACHT	NETHERLANDS	1	
PARIZEAU	CANADA	1	
PARKGRACHT	NETHERLANDS	1	
PATSY & SONS	UNITED STATES	1	
PAVEL VAVILOV	RUSSIA	1	
PETKA	MALTA	5	
POKKINEN	FINLAND	1	
POL AMERICA	PANAMA	4	7
PROBO BARO	NORWAY	3	
PROBO GULL	SINGAPORE	1	
PROTECTOR 2	CYPRUS	1	
PUNICA	LIBERIA	1	
PUTIVL	RUSSIA	1	
RAVENSCRAIG	BAHAMAS	1	
RED ROSE	CYPRUS	4	
RHEA	GREECE	2	
ROJEN	BULGARIA	1	
ROMO MAERSK	DENMARK	1	
SAGA TIDE	NORWAY	1	
SAGA WIND	HONG KONG	2	
SASKATCHEWAN PIONEER	CANADA	1	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
SEA DANIEL	SWEDEN	1	6
SEA PEARL	BAHAMAS	4	
SENTOSA	CYPRUS	2	
SERGEI LEGAR	UNKNOWN	1	
SILVER SEAS II	UNKNOWN	1	
SIR HUMPREY GILBERT	CANADA	3	
SIR JOHN FRANKLIN	CANADA	15	1
SIR WILLIAM ALEXANDER	CANADA	8	
SKOGAFOSS	ANTIGUA/BARBUDA	4	
SKS BANNER	NORWAY	1	
SKS STAR	LIBERIA	1	
SOLBERG	ICELAND	1	
SOLDROTT	NORWAY	1	
SOLON OF ATHANS	CYPRUS	1	
SONORA	MEXICO	2	
SOREN TOUBRO	INDIA	1	
STARLETTE 1	LIBERIA	1	
STAR FLORIDA	NORWAY	1	2
STAR OHIO	LIBERIA	6	17
STAR STRONEN	NORWAY	1	
STEFANIA	SWEDEN	1	1
STELLERHOPE	PANAMA	1	13
STELLANOVA	UNKNOWN	3	7
STEPAN RAZIN	RUSSIA	4	
STOLT ALLIANCE	PANAMA	3	
STOLT ASPIRATION	PANAMA	2	
STOLT PROTECTOR	LIBERIA	1	
STORON	SWEDEN	1	
STRONG ISLANDER	UNITED STATES	5	3
TALTY	MAYLASIA	1	
TALISMAN	DENMARK	8	
TARAGO	BAHAMAS	1	
TERRY FOX	CANADA	10	
THEO C	SWEDEN	1	
TINKA ARCTICA	DENMARK	1	
TORILL KNUTSEN	NORWAY	4	
TORON	RUSSIA	1	
TRADEWIND ISLAND	CANADA	3	
TRANS ARCTIC	NORWAY	2	
TREIMANI	ESTONIA	1	
TROMSBAS	NORWAY	2	

* Sea Surface Temperature

Ship Name	Ship Flag	Ice Report	SST* Report
TURID KNUTSEN	NORWAY	1	
URSA MAJOR	ITALY	2	
URSUS	LIBERIA	1	
VAKARAS	LITHUANIA	1	
VAMAND WAVE	CYPRUS	1	
VARJAKKA	FINLAND	1	
VEGA	LIBERIA	1	
VILJANDI	ESTONIA	1	
VNUKOVO	RUSSIA	1	
VOLSTAD VIKING	NORWAY	1	
VORIOS IPIROS HELLAS	GREECE	1	
WESTERN GREETING	GERMANY	4	
WILFRED GRENFELL	CANADA	11	
WILFRED TEMPLEMAN	CANADA	1	
WISLANES	VANUATU	1	9
WORLD ACTION	HONG KONG	1	3
YA LATIF	PANAMA	4	19
ZIEMIA TARNOWSKA	POLAND	3	3

TOTAL ICE REPORTS	876
TOTAL SST REPORTS	346

* Sea Surface Temperature

Appendix C
Analysis of Limit-Setting Icebergs

CDR Ross L. Tuxhorn and MST3 Tristan T. Krein

Introduction

International Ice Patrol's mission is to identify the Limit of All Known Ice (LAKI) and to transmit this information to mariners at sea. During the ice season, the key element of IIP operations is to conduct reconnaissance patrols to determine the location of icebergs that establish the LAKI.

The LAKI is based on all known iceberg and sea ice information and represents the extent of iceberg danger in the vicinity of the Grand Banks of Newfoundland. From Newfoundland, the line marks the southwestern, southern, and southeastern limits of the iceberg region, and ends at an intersection point with latitude 52°N. Over the last twenty years, at its extremes, the LAKI has extended in the northwestern Atlantic Ocean as far south as latitude 39°N, and in the east to longitude 37°W. In 1995, the southernmost iceberg was sighted at 39°59'N and the easternmost iceberg was sighted at 43°01'W.

International Ice Patrol in recent years has collected data to learn more about the icebergs that establish the LAKI. In 1994, the sources of all sightings south of 45°N were determined. The analysis of this data indicated the large relative contribution of sightings from IIP reconnaissance flights in the area near the limits. This year, the study continued and went further to investigate the attributes of the individual icebergs that set the limits of all known ice.

This information pertaining to the limit-setting icebergs is important as a measure of effectiveness of IIP's surveillance efforts in locating the iceberg hazard. It is IIP's goal to continuously improve its mission performance by effectively locating the icebergs that constitute the LAKI and promptly providing this information to ships to better enable them to avoid encountering icebergs.

Data Collection

Limit-setting icebergs are those icebergs that form the vertices of the LAKI. They are differentiated as eastern, southern, and western limit-setting icebergs by the side of the LAKI "polygon" that they occur at. For the majority of cases in this study, the three categories of icebergs were distinct populations. The few exceptions occurred when icebergs drifted from the southern limit to the eastern limit. In those instances the iceberg's designation was changed accordingly.

Data on the limit-setting icebergs was gathered daily from the output of the Iceberg Data Management and Prediction System (DMPS). Icebergs were recruited as limit-setters either from the 1200Z Ice Bulletin list of "icebergs not in area of many bergs" or from iceberg sightings by the various sources at or near the LAKI. Each day, the icebergs in the limit-setter database were accounted for. The attributes of those icebergs were checked to ascertain any resights or deletions, and any changes were recorded. The following information was determined for each of the designated limit-setting icebergs:

1. DMPS iceberg number.
2. Days on plot in DMPS model.
3. Days as a limit-setting iceberg.
4. Source of sighting when entered in limit-setter data base, and any subsequent resighting source.
5. Location on LAKI -- W, S, E.
6. Method of deletion: Collection of data on a given limit-setting iceberg ended when it was deleted from DMPS by standard IIP criteria There are two reasons why IIP removes an iceberg from DMPS:
   a. The iceberg deterioration model predicted the iceberg has melted (Anderson, 1983)

b. The area around the predicted position of the iceberg has been thoroughly searched either through visual or double radar coverage.

Discussion

During the 1995 season, 144 icebergs determined the LAKI. Table 1, lists the sources of the limit-setting icebergs when they were initially sighted, or first entered into the iceberg drift model, and when they were last sighted in the area of the LAKI. The table shows that IIP reconnaissance was the primary contributor of icebergs that eventually established the LAKI and the major sighting source of the icebergs prior to their melting completely and ceasing to exist.

Table 1
Sources of LAKI Icebergs

Sighting Source	Initial Report (% of Total)	Final Report (% of Total)
Coast Guard (IIP)	48	50
Other Air Recon (GPCD)	16	27
Canadian AES (GCFR)	7	3
BAPS	15	0
Ships	12	17
Other	2	3

Locations of the initial sightings of the eventual limit-setting icebergs by sighting source are shown in the chart series 1A-1E. From these charts, an appreciation of the operational methods of each iceberg sighting source can be discerned. IIP reconnaissance effort was concentrated on the southern LAKI. Other air reconnaissance, which consisted of Provincial Airlines LTD (GPCD) flights in 1995, was accomplished in conjunction with fisheries patrols and focused on the slope of the Grand Banks. Canadian AES (GCFR) conducted iceberg surveillance as a secondary function to its sea ice reconnaissance, and the sightings were associated with the sea ice edge. BAPS sightings are icebergs that are handed off by the AES iceberg model to the IIP iceberg drift model at 52°N latitude. Ships sighted and reported icebergs at the southern LAKI where they are carried by the currents across the great circle shipping lanes between North America and Europe. Five of these iceberg sightings were actually outside the LAKI and prompted the issuance of safety broadcasts of revised limits.

Table 2
Initial Iceberg Sighting Sources With Respect to LAKI Region

Sighting Source	LAKI Icebergs West	South	East	Combined Count
Coast Guard (IIP)	11	47	11	69
Other Air Recon (GPCD)	2	11	10	23
Canadian AES (GCFR)	5	3	2	10
BAPS	4	5	13	22
Ships	1	11	5	17
Other	0	3	0	3
				144

Table 2, shows the initial sighting sources for the three categories of icebergs: western, southern, and eastern limit-setters. Examination of the numbers reveals that IIP provided over half of the sightings for the western and southern LAKIs. Ship reported LAKI icebergs were mostly near the southern LAKI. And, iceberg reports supplied by GPCD and BAPS were the important initial sources for icebergs that comprised the eastern LAKI.

Analysis of the data indicates that approximately half of the icebergs at the LAKI made it through IIP's operations area, from 52°N to the waters south and east of the Grand Banks, unde-

tected by reconnaissance other than IIP's. Of the icebergs that were resighted as they made the journey to the LAKI, IIP, GPCD, and ships found the majority of them. The size distribution of the limit-setting icebergs, as reported by the final sighting source, is displayed in Table 3. Almost half of the sightings were reported as "general sized icebergs", which is the unspecified size assigned to icebergs detected by IIP radar surveillance.

Table 3
Deletion Method of LAKI Icebergs

Method	% of Total
150% Melt	79
200% Radar Coverage	13
Visual Recon Coverage	8

As tool for maintenance of the LAKI, the study shows that IIP's melt model is very important. From Table 4, 79% of the limit-setters were deleted after reaching 150% melt. Non-detection of icebergs during reconnaissance patrols accounted for 21% of the deletions of the icebergs that comprised the LAKI.

Table 4
Size Distribution of LAKI Icebergs

Size Category	% of Total
Growler	5.6
Small	15.3
Medium	15.3
Large	12.5
Very Large	2.8
General	48.5

Conclusion

The results from this work have yielded a better understanding of the contributing surveillance sources and the final fates of the limit-setting icebergs. In the 1995 Season, 3180 icebergs were entered in the IIP iceberg drift model, of which 144 made it through the IIP operations area to set the LAKI. If the 1995 Season can be considered typical, then the great majority of icebergs (95%), which pass south of 52°N latitude, melt before they approach near the LAKI.

A significant finding of this study is that approximately half of the limit-setting icebergs were undetected before being found near the LAKI by the various surveillance sources, primarily IIP reconnaissance. For this to happen, the icebergs had to either make it through the gauntlet of reconnaissance undetected or be created in the region near the LAKI. If the latter is considered, it implies that the splitting of icebergs into two or more "pieces" as they journey south, and especially in the vicinity of the LAKI, is an important process of their melt. Both deductions exceed the scope of this study, however, are ripe for further investigation. But, regardless of how they get there, the fact that these icebergs are found at the LAKI gives impetus to IIP reconnaissance in this region.

References

Anderson, I. Iceberg Deterioration Model, Report of the International Ice Patrol in the North Atlantic, 1983 Season, CG-188-38, U.S. Coast Guard, Washington, D.C., 1983.

Chart 1a

Initial Sighting Positions of Limit-Setting Icebergs from USCG (IIP) Reconnaissance (CG-1501/CG-1504)

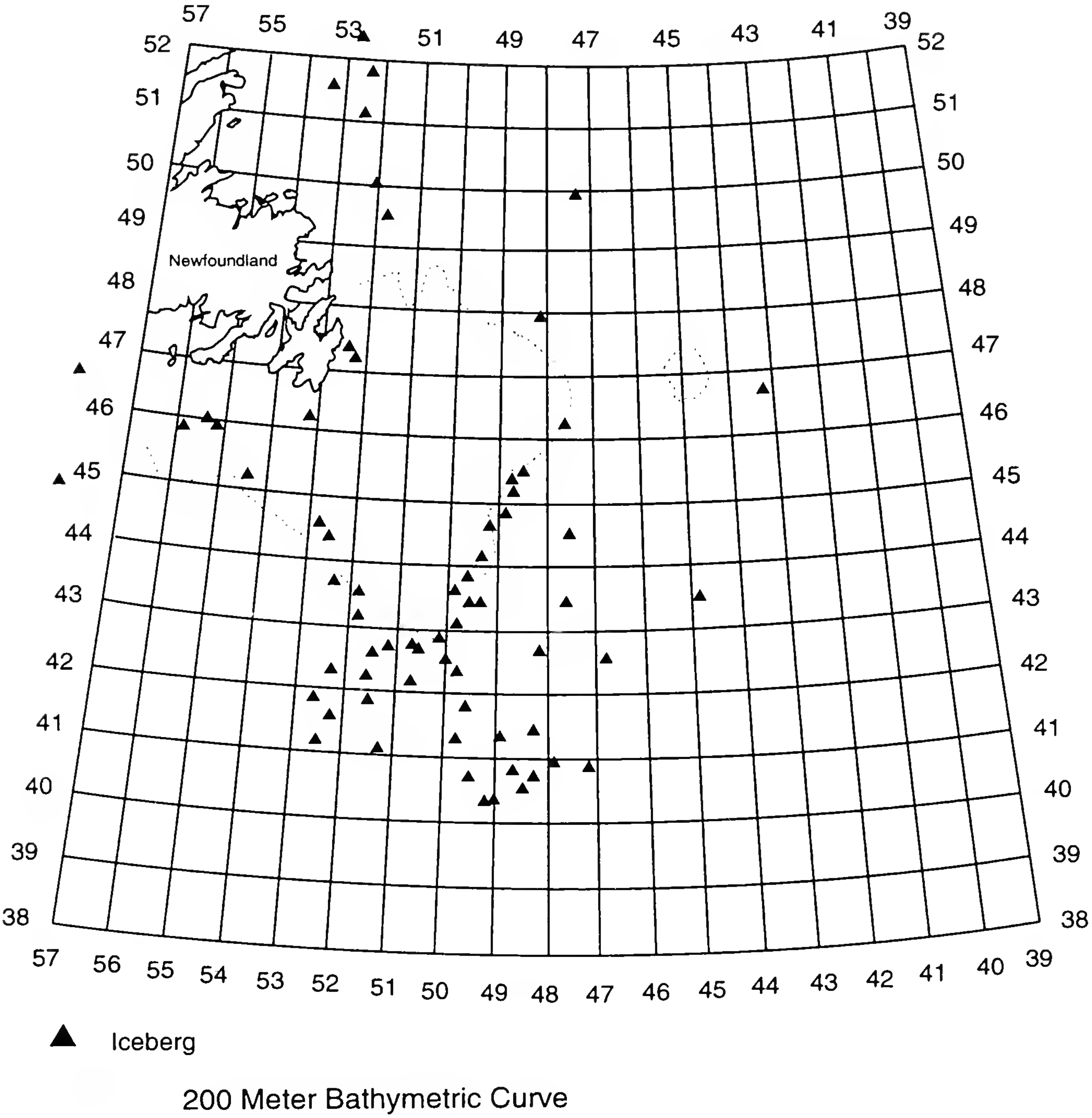
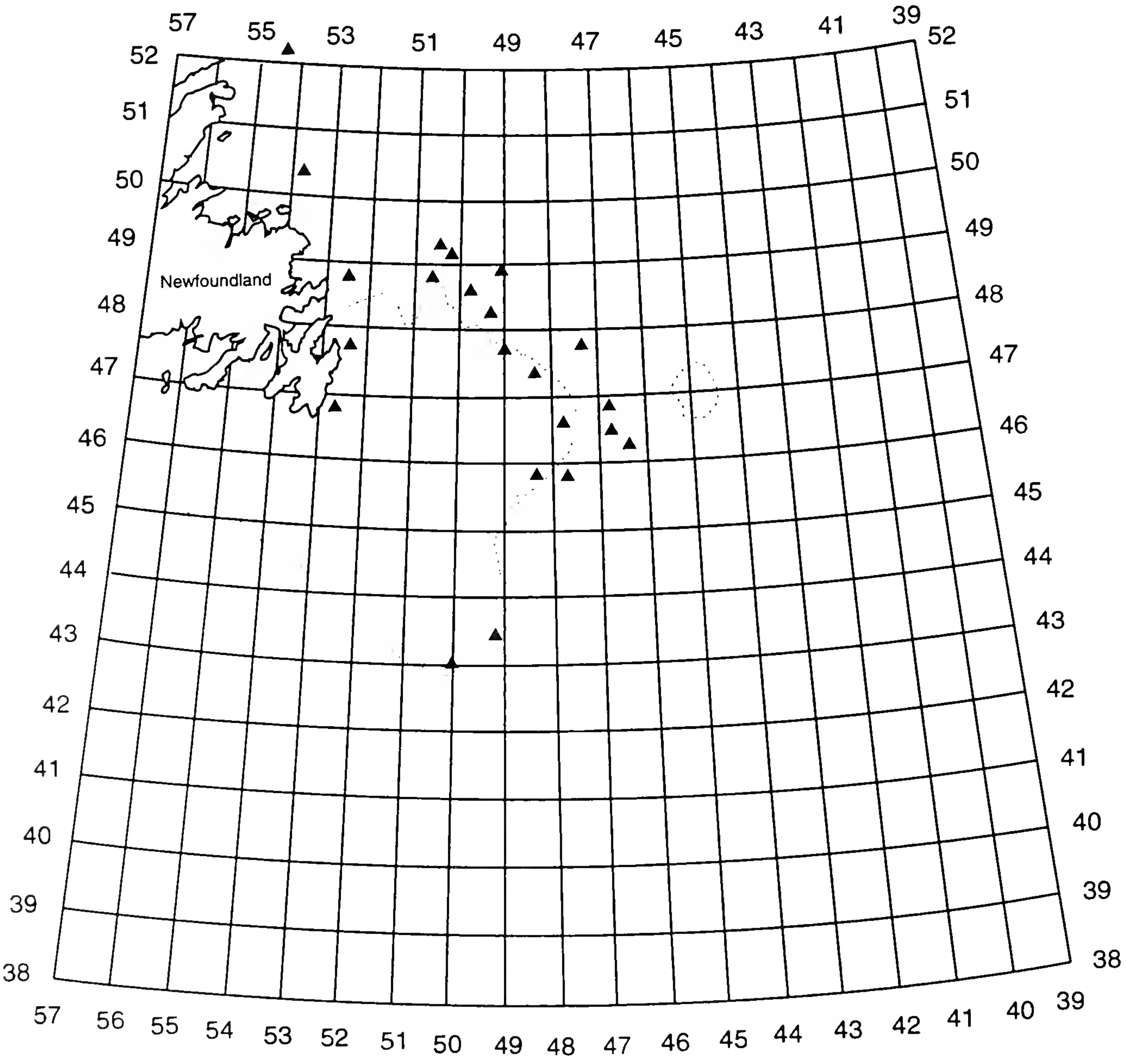


Chart 1b

Initial Sighting Positions of Limit-Setting Icebergs from Other Air Reconnaissance, Provincial Airlines, Ltd.(GPCD)

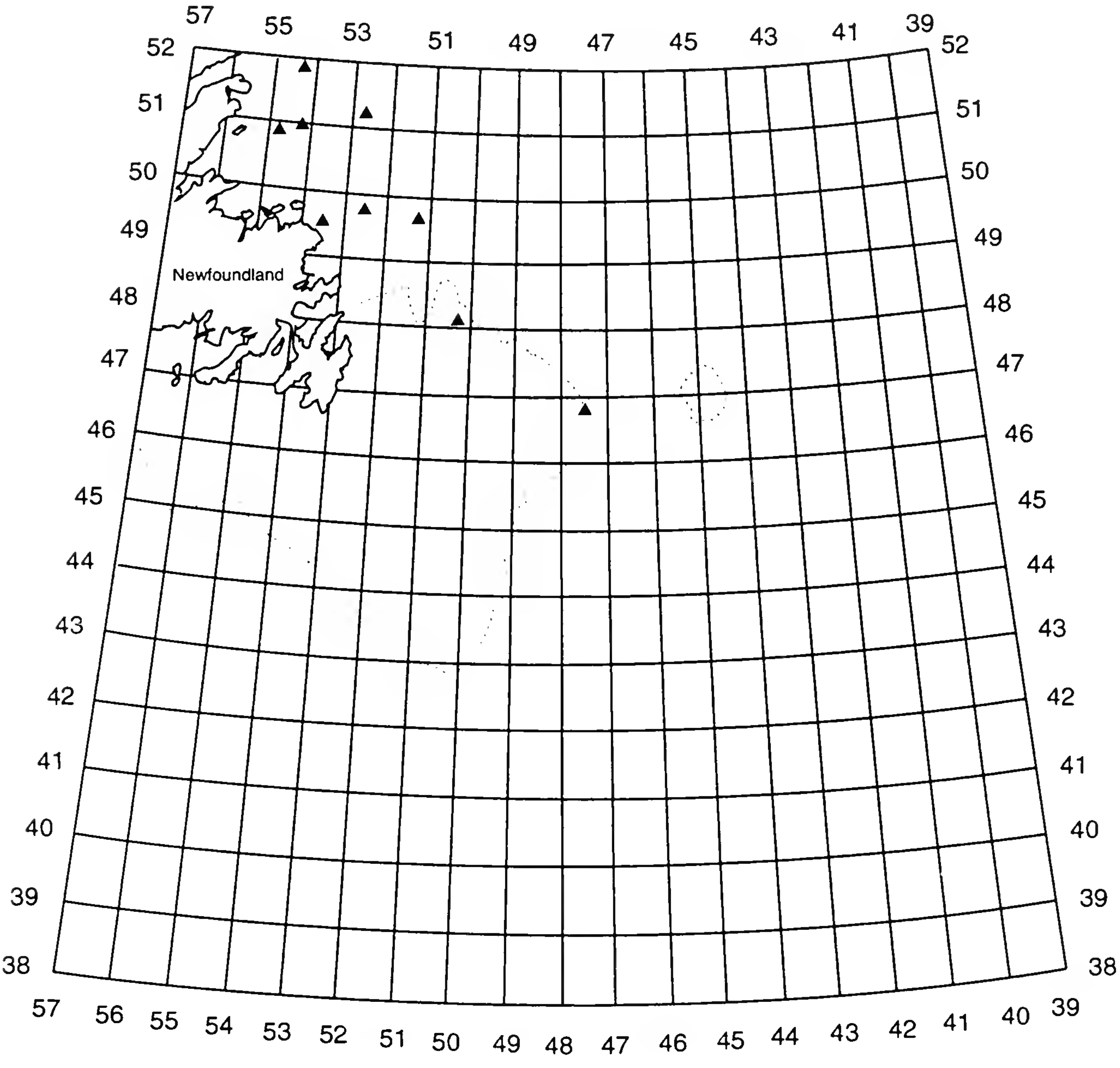


▲ Iceberg

200 Meter Bathymetric Curve

Chart 1c

Initial Sighting Positions of Limit-Setting Icebergs from Canadian AES Reconnaissance (GCFR)

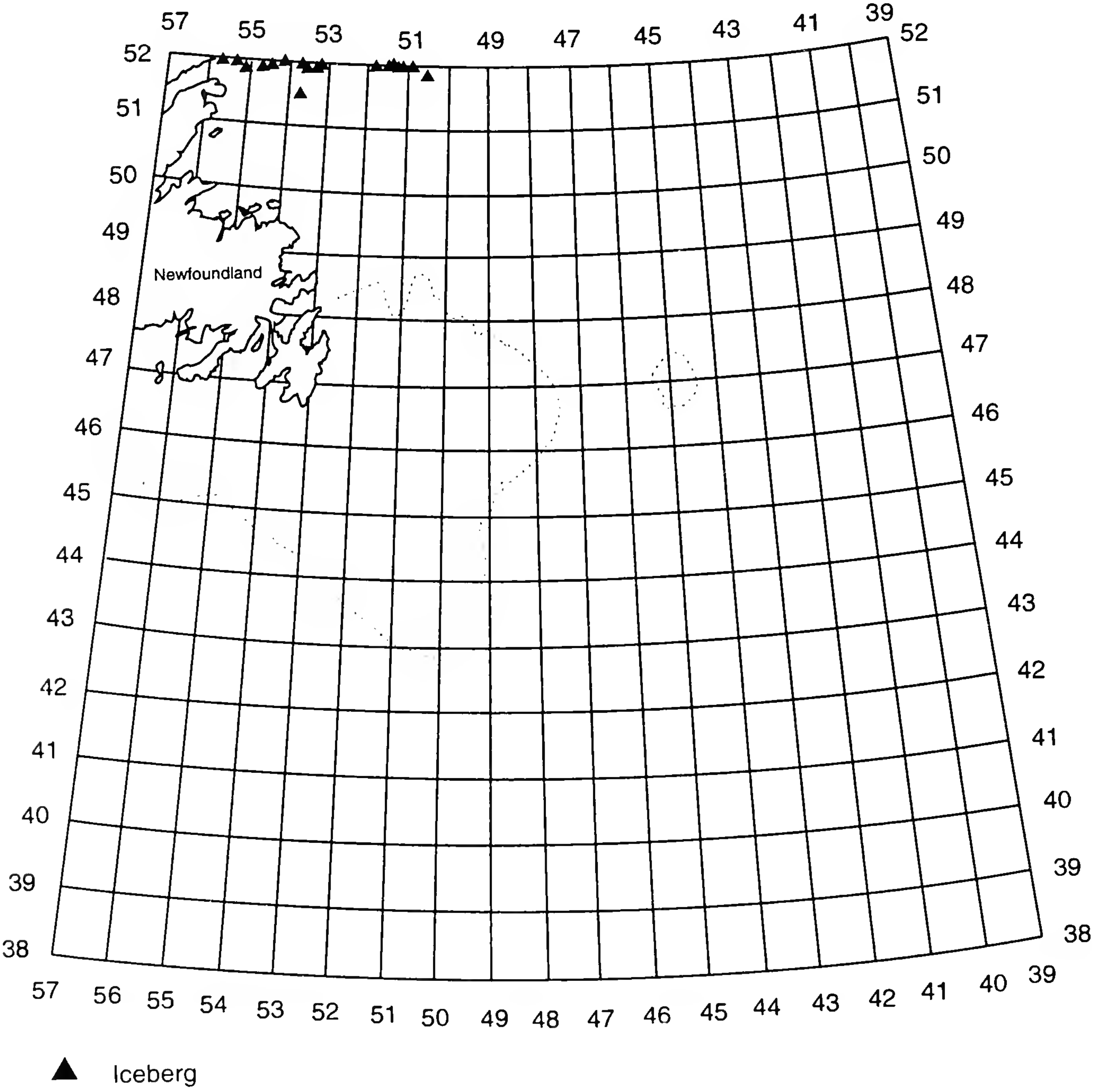


▲ Iceberg

200 Meter Bathymetric Curve

Chart 1d

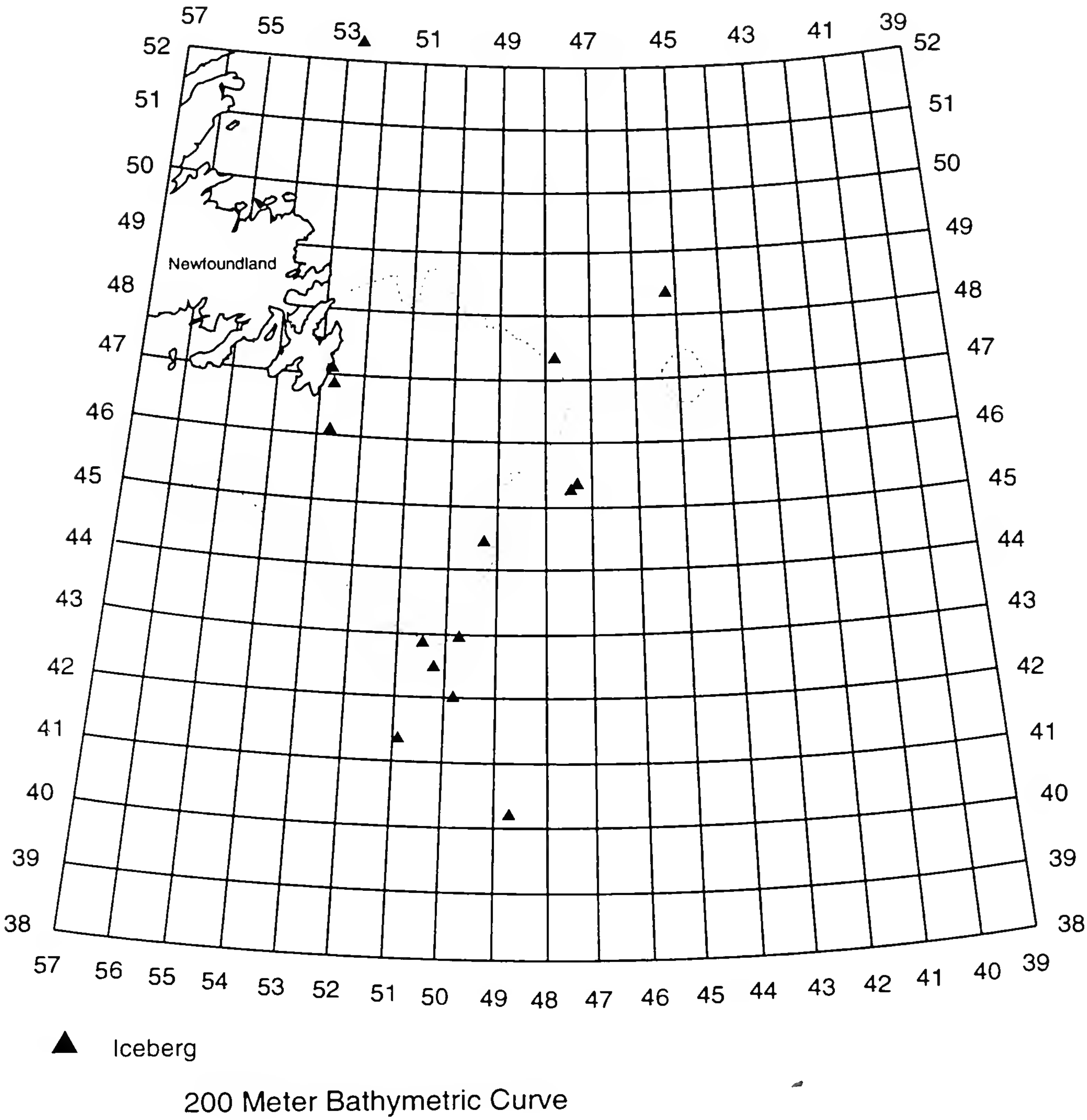
Initial Sighting Positions of Limit-Setting Icebergs from BAPS Bergs Crossing 52°N (BX52N)



200 Meter Bathymetric Curve

Chart 1e

Initial Sighting Positions of Limit-Setting Icebergs from Ship Reports



Appendix D

Product User Survey

MST3 Tristan T. Krein

Introduction

During the 1995 ice season, a product user survey was sent to trans-Atlantic mariners to help determine the quality and importance of our services in the eyes of our customers. The survey was transmitted to the mariner by the same means as the Ice Patrol's products, twice via INMARSAT-C and once by high frequency (HF) radio facsimile. The first INMARSAT survey, transmitted May 11 over the AOR-W satellite, netted a total of 103 responses. The second INMARSAT survey, sent August 3, brought an additional 85 responses, with the August 1 facsimile broadcast yielding only 3. The total of 191 responses was a sevenfold increase of returns in comparison to a similar survey conducted by mailing questionnaires to shipowners in 1993. Although the vast majority of responses were by ships that actively utilized IIP products, 7 unanswered surveys were returned by vessels not normally operating in the area.

The survey was drafted in 1995 with the help of Dr. Robert Armacost, the management consultant who directed the IIP Cost and Operational Effectiveness Analysis. The following is a general breakdown of the 18 questions asked, along with the number of applicable responses given in percentages. Comments have been included to provide further insight on some inconsistencies or ambiguities encountered with responses, questions, or methods used to tally results. Also note that the figures presented reflect the 184 surveys answered, and disregard the 7 returned blank.

Survey and Data Collection

When you are operating in the IIP area (40°N-52°N, 39°W-57°W):

1. "Do you receive the IIP SAFETYNET BULLETIN at least once a day?"

66%-Always
19%-Usually
8%-Sometimes
2%-Never
4%-Unsure

2. "Do you receive the IIP SITOR BULLETIN at least once a day?"

33%-Always
22%-Usually
13%-Sometimes
19%-Never
13%-Unsure

3. "Do you receive the IIP NAVTEX BULLETIN at least once a day?"

61%-Always
22%-Usually
10%-Sometimes
5%-Never
2%-Unsure

4. "Do you receive the IIP HF FACSIMILE CHART every day?"

36%-Always
26%-Usually
21%-Sometimes
11%-Never
5%-Unsure

5. "Do you record the Limits of All Known Ice from voice broadcasts?"

25%-Always
13%-Usually
20%-Sometimes
39%-Never
3%-Unsure

NOTE: Only vessels equipped to receive INMARSAT and radio FAX transmissions would have received a survey. Any ship relying on voice broadcasts as a main/sole source of message traffic would have been unaware of the survey's existence and unable to participate.

6. "Do you keep the Bulletin or Ice Chart available in the pilot house?"

88%-Always
6%-Usually
1%-Sometimes
2%-Never
3%-Unsure

7. "Do you plot the Limits of All Known Ice on your navigation chart?"

88%-Always
8%-Usually
1%-Sometimes
2%-Never
1%-Unsure

8. "Do you plot the location of icebergs on your navigation charts?"

80%-Always
13%-Usually
5%-Sometimes
1%-Never
1%-Unsure

9. "Do you change your course on a regular basis to pass outside the Limits of All Known Ice?"

51%-Always
28%-Usually
18%-Sometimes
3%-Never
1%-Unsure

NOTE: Without clarification it is difficult to determine whether some ships do not alter their course because they don't need to, don't want to, or are unable to.

10. "Does your course take you inside the Limits of All Known Ice?"

7%-Always
15%-Usually
44%-Sometimes
31%-Never
4%-Unsure

NOTE: The question does not specify between altered and original courses.

11. "Do you report iceberg sightings to the IIP?"

54%-Always
13%-Usually
13%-Sometimes
9%-Never
2%-Unsure

NOTE: The other 10% answered that they had "never seen any" icebergs. Without such clarification, it is difficult to ascertain whether the ships answering "Sometimes" or "Never" even see icebergs, or if they just don't report the ones they see.

12. "Do you make weather reports with sea surface temperatures in the IIP area?"

38%-Always
15%-Usually
19%-Sometimes
24%-Never
4%-Unsure

13. "How valuable are the IIP products?"

98%-Very Valuable
2%-Somewhat Valuable
0%-Not Valuable

14. "Please rank the importance of the IIP products (1=most important, 4=least)"

1.4 - Ice Bulletin
1.8 - NAVTEX Broadcast
1.8 - HF Facsimile Ice Chart
3.1 - Voice Broadcast

NOTE: The figures presented are averages. Many mariners misunderstood the question and rated each product on a scale of 1 to 4. Others assigned a value to only some of the products and left the others blank. Since no one can reasonably guess a response, and assigning a 0 would unfairly lower averages (thereby raising the level of importance), the blanks were disregarded and each product was averaged individually by dividing its total with the number of figures it actually received. The products rated instead of ranked were averaged with the figures the mariners assigned them. Because of these inconsistencies, the actual figures presented should not be taken too literally, but do provide a valid general comparison. See comment for question 5 in regards to popularity of voice broadcasts.

15. "How many transits do you make through the IIP area each year during March through September?"

NOTE: 4.1 transits was the average, with 20 tansits being the highest and 0 the lowest.

16. "Please indicate the type of vessel that you usually operate."

30% - Bulk
18% - General Cargo1
4% - Container
9% - Oil Tanker
7% - Other Tanker
7% - Reefer
4% - Unspecified
3% - RO/RO
1% - Research, Heavylift, OBO, Passenger, Multipurpose
(Less than 1%) - Fishing, Sailing, Live stock, Cable Layer, LPG

17. "Compared to conditions when there are no icebergs and IIP is not in operation, please estimate the number of extra hours of enroute time that are required on an average transit to avoid icebergs or to remain outside the Limit of All Known Ice."

NOTE: 16.1 Hours was the average time for the 100 responses to this question, with a low of 0 hours and a high of 96 hours.

18. "Based on your experience, how accurate is the Limit of All Known Ice?"

37% - Extremely accurate (icebergs never seen outside the Limit of All Known Ice)
54% - Very accurate (icebergs occasionally seen outside the Limit of All Known Ice)
9% - Somewhat accurate (icebergs usually seen outside the Limit of All Known Ice)
0% - Never accurate (icebergs always seen outside the Limit of All Known Ice)

COMMENTS

A space was provided at the end of the survey to allow for comments or suggestions. Although the majority of these were left blank, 59 generic comments were received in praise of our services and imploring their continuation. Suggestions included involving more merchant ships to do ice reporting, extending the period of services, and even installing radar reflectors on icebergs. A few comments were made in reference to slightly exaggerated limits or individual icebergs not being located in the positions they were estimated to be. This suggests a tendency of some mariners to mistake prognostic estimates as fact, a potentially dangerous misconception we seek to avoid.

Appendix E

IIP Iceberg Limits Climatology (1975-1995)

CDR Bruce E. Viekman and MST3 Kenneth D. Baumer

Introduction

International Ice Patrol (IIP) provides a service which monitors the extent of the iceberg danger in the vicinity of the Grand Banks of Newfoundland. This danger area is passed to interested shipping as a broadcast Limit of All Known Ice (LAKI). In order to define this limit as accurately as possible, IIP uses reports from various sources. These include icebergs detected by IIP and Canadian aircraft reconnaissance and reports from passing vessels. The path of reported icebergs since sighting is predicted using the momentum balance for each target (Mountain, 1980), and the deterioration of each iceberg is estimated using wave and sea surface temperature analyses from U. S. Navy models (Anderson, 1983). IIP watchstanders attempt to correlate new sightings with prior observations through the process of resights (Viekman, 1993). The broadcast LAKI therefore reflects all iceberg sightings entered into the model, IIP's knowledge of the oceanic circulation, and estimations of drift based on other environmental products, and the cumulative actions of IIP watchstanders.

The iceberg limits vary considerably through the ice season and between seasons. IIP has historically tracked the number of icebergs crossing 48 degrees North latitude, and this "count" forms the principal measure of iceberg season severity (Trivers, 1994; see Anderson, 1993 for a comprehensive review of the methods used to determine this statistic). This count has the advantage of providing a single value for the season severity, but suffers in other ways. It does not address the area covered by the iceberg population, which impacts the trackline deviation required for mariners to stay clear of the danger zone. The extent of the LAKI also drives aircraft requirements for IIP reconnaissance.

The goal of this work is to determine a climatology for the IIP Limits of All Known Ice using historical records. The variability of the LAKI will be considered through the typical IIP ice season using the 21 year period from 1975 to 1995, inclusive. This period was selected for two reasons. First, the LAKI for this period were calculated using a computerized vector drift (1974 to 1979) or dynamical force balance model (1979 to 1995). These models were used to track most iceberg reports, even those far from the LAKI (Anderson, 1993). Secondly, LAKI from this period are reliably presented in the IIP Annual Report. Before 1974, the IIP Annual Report shows only the sighted position of icebergs, and does not give the results of the manual vector addition used to predict iceberg movement.

Two prior studies have investigated iceberg climatological limits. The Pilot Charts for the North Atlantic Ocean (Defense Mapping Agency, 1992) show a 'mean maximum iceberg limit' on each month's chart, along with unusual iceberg reports. The source of this limit is not known, and publication of the North Atlantic Pilot Chart ceased in 1992.

Mudry (1991) prepared a climatology based on IIP sightings for the period of 1960 to 1982, the period where visual aircraft reconnaissance was used. While this data provided a comprehensive frequency of aircraft sightings, it did not include the iceberg drift predictions by IIP. A climatology for sea ice distribution for the period 1962-1987 was completed by Cote (1989).

Methods

The Limits of All Known Ice (LAKI) as published in the IIP Annual Report were used in this study. Since 1980, iceberg density and limits were published in the IIP Annual Report on the 15th and 30th of each month during the ice season.

For the period of 1984-1995, the average ice season began on March 9 and closed on August 15. LAKI data was available for analysis from March 15 to July 30. Before 1980, data was presented without this regularity. For that period, the limit setting icebergs were drifted using the operational drift model for several days to estimate the iceberg limits on the 15th or 30th, provided the duration of drift was less than 7-9 days. This drift estimate was made with calm winds, and iceberg deterioration was not considered. A summary of the available data is given in Table 1. In most cases the missing data simply reflects that in a given year the season began after the mean start date, or ended before the mean stop date. In a few cases, however, the bulletin did not show data for the given date.

For each case, the LAKI was re-drawn using current policy. The LAKI is drawn as a convex polygon enclosing the iceberg region, and is offset from the extreme icebergs using an error circle of 30 nm. Since IIP policy is to connect the limit-setting icebergs with rhumb lines, the LAKI sometimes encloses areas were icebergs are absent. This policy enables IIP to broadcast an alphanumeric product, and gives the simplest shape defining the iceberg danger region. It also provides the mariner with a convenient method of receiving the report. Limits, by definition, include all the ice of which IIP has knowledge. Therefore the extreme limits can be set by a single iceberg which is far separated from others.

Following this analysis the LAKI were digitized. Each one degree latitude/longitude square was considered to be inside the limits if over half of the area was within the LAKI, and a value of 1 was assigned to these blocks. Those blocks outside the limits were assigned a value of zero. The mean value for each block was then computed. This method provides the probability that a given square was within the LAKI on the given date for the analysis period.

The Climatological LAKI

The annual progression of the climatological limits reflects the dominant features of the oceanic circulation within the IIP operations area (Figures 1-11). Icebergs are carried south by the Labrador Current. Icebergs close to Newfoundland move slowly southward on the inshore branch of the Labrador Current, while the faster moving, offshore branch (30-40 cm/s) carries the icebergs southward along the eastern edge of the Grand Banks.

The traditional height of the IIP season is often viewed to be mid-April. This is probably due to the sinking of the RMS TITANIC on April 15, 1912 at 41-54N, 50-14W. It is notable that the position of the disaster is outside the 25th percentile limit, but within the extreme limit of this modern period. This climatology shows that the most extensive limits occur in May (Figures 6 and 11). Both median and extreme limits reach their maximum on May 30. The median limit is 40 nm south of the Tail of the Grand Bank (42-20N), and the limits have been as far south as 38-30N (1990). To the east, the median limit includes Flemish Cap (a bank near 47N, 45W) throughout the year. Icebergs which are not carried south by the offshore branch of the Labrador current tend to drift eastward, passing to the north of Flemish Cap. By late July, the limits have retreated near 45N with warming sea surface temperatures.

Early in the ice season, the extreme limits are about 120 nm south of the median limit, and are located about 60 nm south of the Tail of the Grand Banks. In 1983, an unusual number of icebergs were carried south by the inshore branch of the Labrador Current, extending the extreme limits to 41N, 54W on 15 March. In May, the extreme limits are up to 200 nm south of the median limit, and this inter-annual variability extends through the end of the ice season. The minimum iceberg limit remains north of 47-30N, and west of 50W, except for July when the minimum limit moves eastward to 47W by month's end.

The median limits (Figure 11) show a similar, but smaller, seasonal progression to the extreme limits. Their southward extent agrees well with the bathymetry of the Grand Banks and the flow of the Labrador Current.

Comparison with climatologies based on sightings

Data presented in the IIP annual reports for 1945 through 1974 varies from the analysis described above, as only iceberg sightings were reported. Aircraft flight tracks and sightings were available for 1967 to 1974. Ship reports were not published for the period, but the flight tracks are assumed to cover the areas where icebergs had been reported by ships. From 1945 to 1966, the annual report plots the position of all targets regardless of sighting source. Iceberg limits were prepared based on the most recent sightings in the same manner in the previous analysis for two dates, April 15 and May 30. A summary of the available data is given in Table 2.

Limits based on sighting data alone are less extensive than those based on sightings plus drift (Figures 12, 13). For April 15, the median limit from sighting data is 120 nm north of the median limit from current IIP practices (Figure 3). The extreme limit based on sightings is near the 30th percentile limit from the recent data. The southern extent of the median limits for May 30 shows a similar 120 nm difference, however the extreme southeastern and eastern limits are comparable. While 1972 and 1974 were extreme ice seasons (based on the number of icebergs passing south of 48N), the geographic extent of the limits far less extensive than that found for 1975-1995.

The Mudry (1991) frequency of iceberg sightings compares well with the sightings-only limits determined here. The region where icebergs were sighted with 40% to 60% frequency extends south to 43N, 50W (the Tail of the Grand Bank), and icebergs were sighted as far south as 39N, with one outlier at 36-30N, 49W. To the east, the median frequency extends to 45W near Flemish Cap.

Conclusions

This paper presents a climatology of the extreme distributions of icebergs in the North Atlantic based on the International Ice Patrol Limits of All Known Ice for the period of 1975-1995. The limits presented here are one limited representation of the iceberg distribution. They represent the cumulative effects of reconnaissance, reporting, IIP's knowledge of the regional oceanic circulation, wind data, and the activities of IIP operations personnel. The limits are also only instantaneous presentations for discrete times. For example, an extreme iceberg may be reported on the second of the month, and be deleted due to predicted deterioration or reconnaissance on the 14th, and not be represented in the basic data used here.

Another realization of the iceberg distribution is the iceberg sighting positions over time, but sighting data is also limited by reconnaissance distribution, frequency, and effectiveness. While this climatology seeks to forecast the fate of sighted icebergs, errors in the drift calculations arising from unknowns in ocean circulation are potentially large.

Substantial differences exist between the 1945-1974 limits climatology, based on sightings alone, and the more recent data. The limits based on sightings alone are more compact than the modern limits. Changes in the distribution of sightings, and changes in reconnaissance areas, may be investigated through the sighting data base. These may provide insight as to whether these differences are due to changes in the true iceberg distribution or simply to changes in the areas searched.

Date	Years Missing Data	Years Drifted, # of Days
15 March	76, 78, 84, 86, 88	75 - 8 days 79 - 9 days
30 March	88	75 - 4 days 76 - 3 days 78 - 6 days 79 - 6 days 86 - 3 days
15 April	None	79 - 9 days 80 - 6 days
30 April	79	None
15 May	None	None
30 May	78	None
15 June	79, 80	None
30 June	75, 77, 78	None
15 July	75, 77-80, 86	None
30 July	75-78, 80, 81, 86	None

Table1

Data availability for 1975-1995. 'Years data missing' give periods when the IIP Annual Report did not contain data within 9 days of the analysis date. Years drifted give those years when limit setting icebergs were drifted using IIP's operational model to bring the available data up to the analysis date.

Date	Years Missing Data	Years Drifted # of Days
15 April	51, 53, 58, 60	63 - 6 days 65 - 6 days 69 - 6 days 70 - 4 days 71 - 3 days
30 May	46, 51-53, 58, 60, 63, 70, 73	45 - 6 days 49 - 7 days 50 - 5 days 52 - 9 days 56 - 4 days 59 - 6 days 60 - 4 days 62 - 9 days 64 - 8 days 65 - 5 days 67 - 4 days 69 - 6 days 72 - 7 days

Table 2

Data availability for 1945-1974. 'Years data missing' give periods when the IIP Annual Report did not contain data within 9 days of the analysis date. Years drifted give those years when limit setting icebergs were drifted using IIP's operational model to bring the available data up to the analysis date.

References

Anderson, I., 1983, "Iceberg Deterioration Model", Report of the International Ice Patrol in the North Atlantic Ocean, Season of 1983, (CG-188-38), pp. 67-73.

Anderson, I, 1993, "International Ice Patrol's Iceberg Sighting Data Base, 1960-1991", Report of the International Ice Patrol in the North Atlantic Ocean, Season of 1993, (CG-188-48), pp. 49-80.

Cote, P. W., 1989. Ice Limits, Eastern Canadian Seaboard, Ice Centre Environment Canada, Ottawa, Ontario. 39 pp.

Defense Mapping Agency, 1992. Atlas of Pilot Charts - North Atlantic Ocean. 37 pp.

Mountain, D. G., 1980, "On Predicting Iceberg Drift", Cold Regions Science and Technology, Vol I (3/4), pp. 273-282.

Mudry, D., 1991, "Monthly Climatological Iceberg Limits," Unpublished Manuscript, Ice Centre Environment Canada, Ottawa, Ontario. 14 pp.

Trivers, G. A., 1994, "International Ice Patrol's Iceberg Season Severity", Report of the International Ice Patrol in the North Atlantic Ocean, Season of 1994, (CG-188-49), pp. 49-59.

Viekman, B. E., 1993, "IIP Iceberg Resights - 1992 and 1993 Seasons," Report of the International Ice Patrol in the North Atlantic Ocean, Season of 1993, (CG-188-48), pp. 87-90.

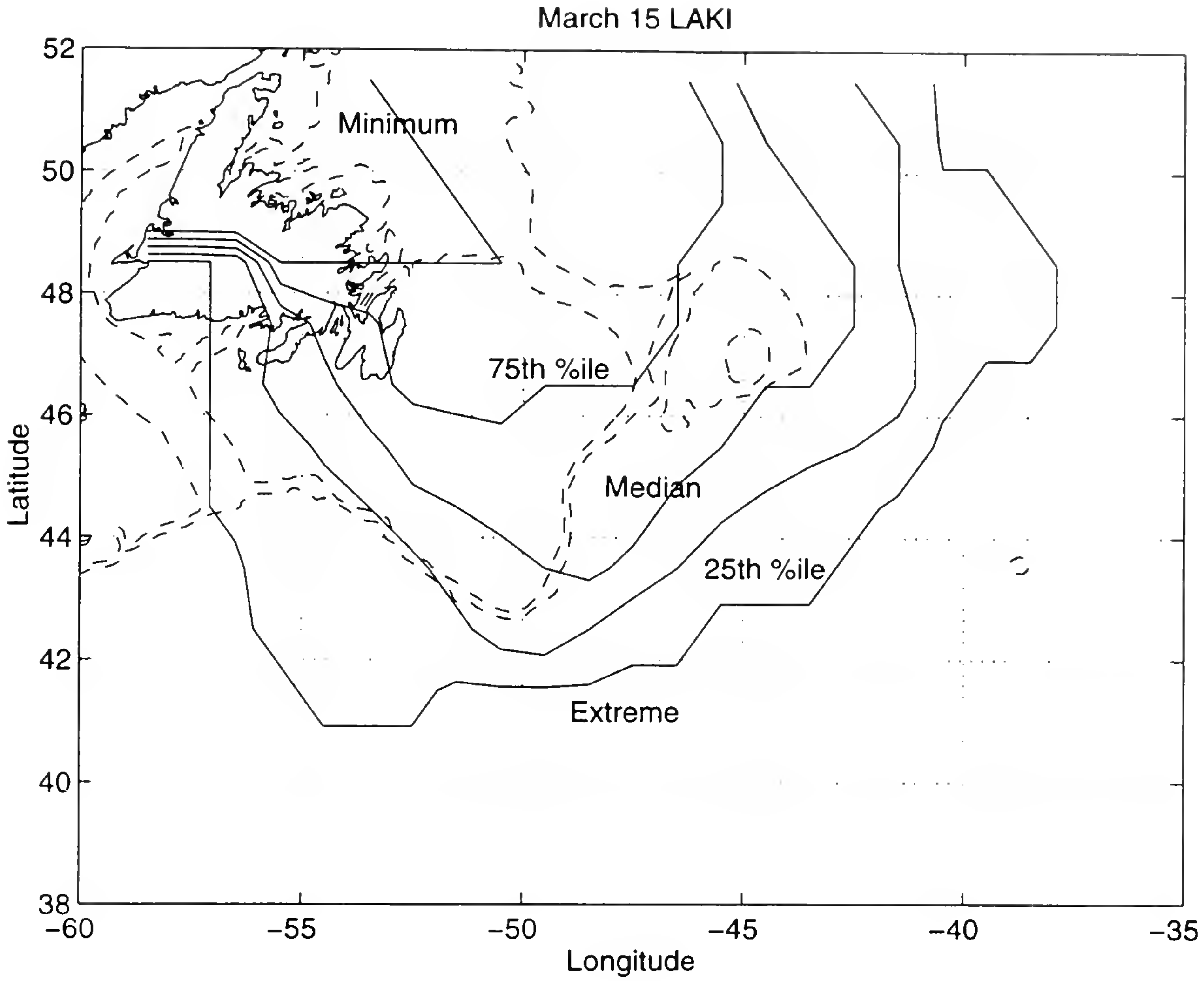


Figure 1

March 15 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995. Data availability is given in Table 1. Solid contours enclose equal occurrence that the limits of all known ice are within the given area for the study period (see text). Dashed contours show the 200 m and 1000 m isobath.

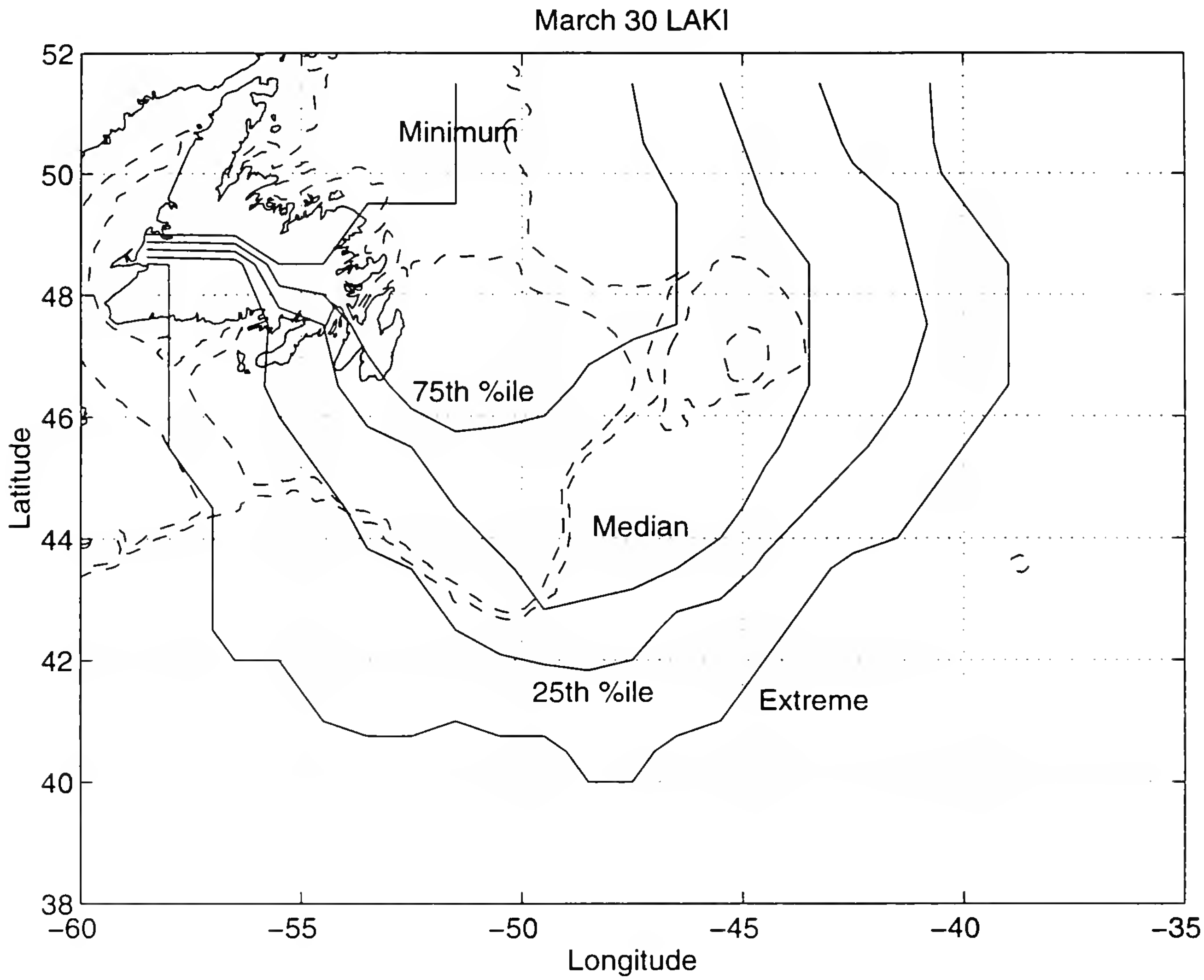


Figure 2

March 30 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

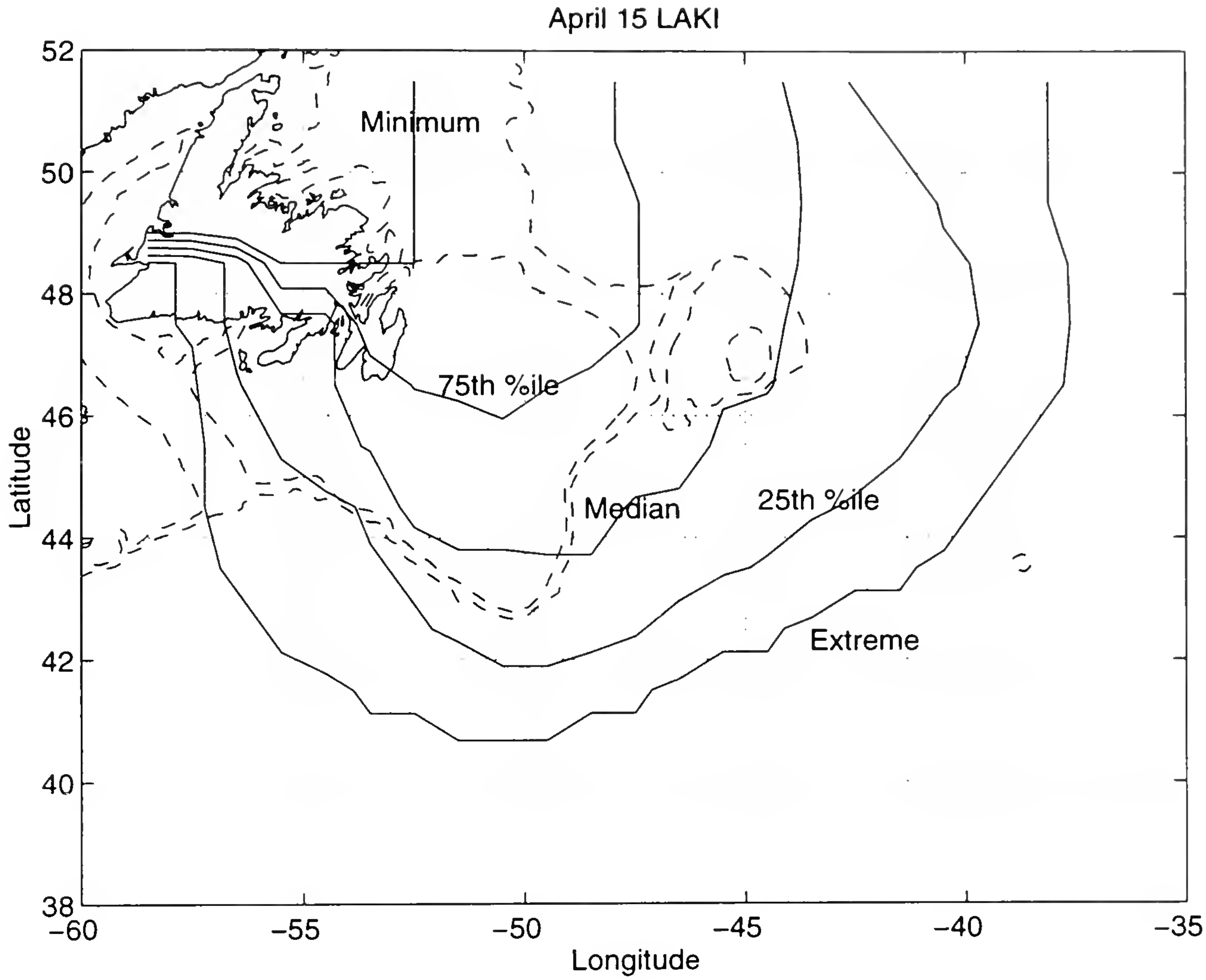


Figure 3

April 15 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

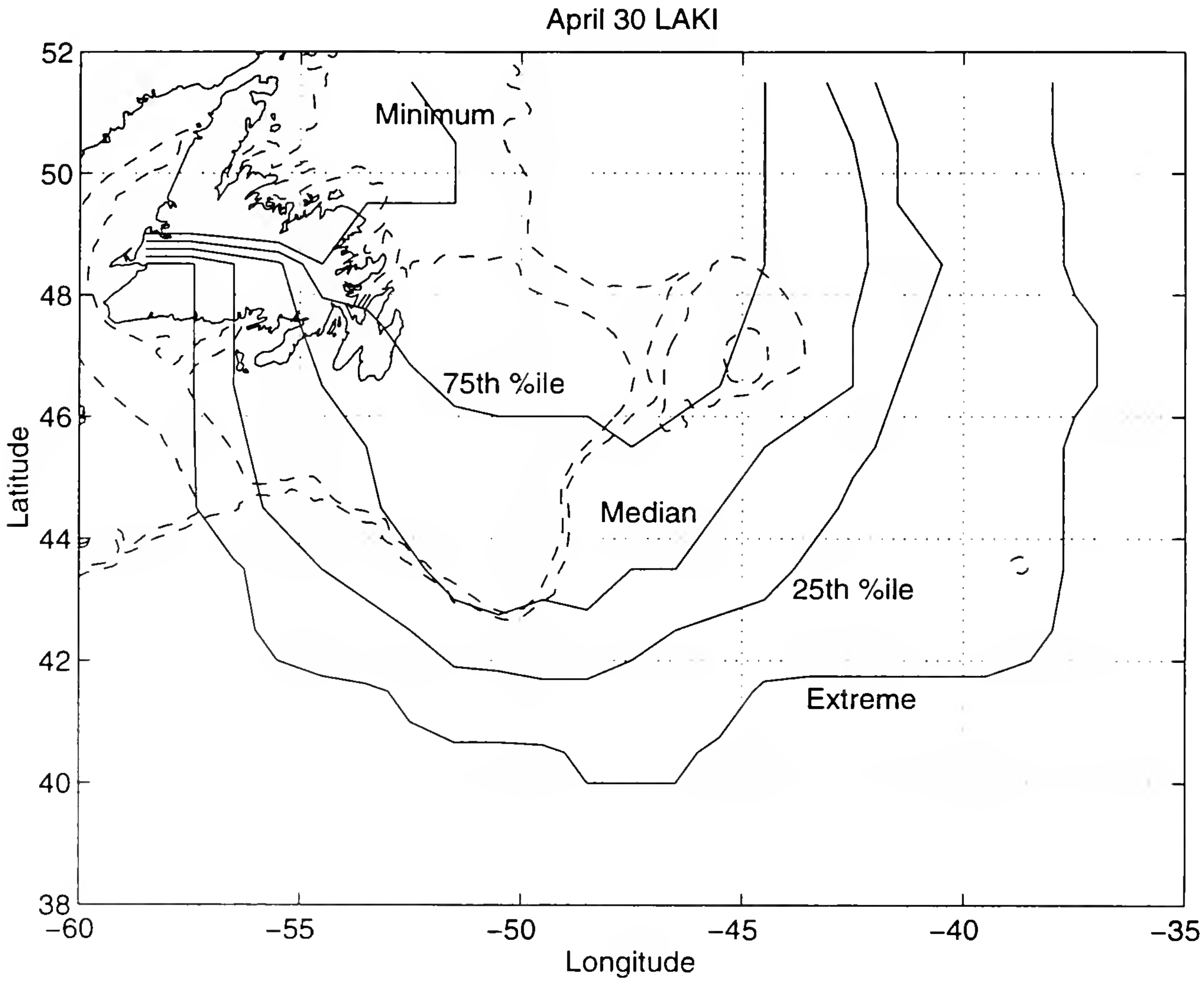


Figure 4

April 30 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

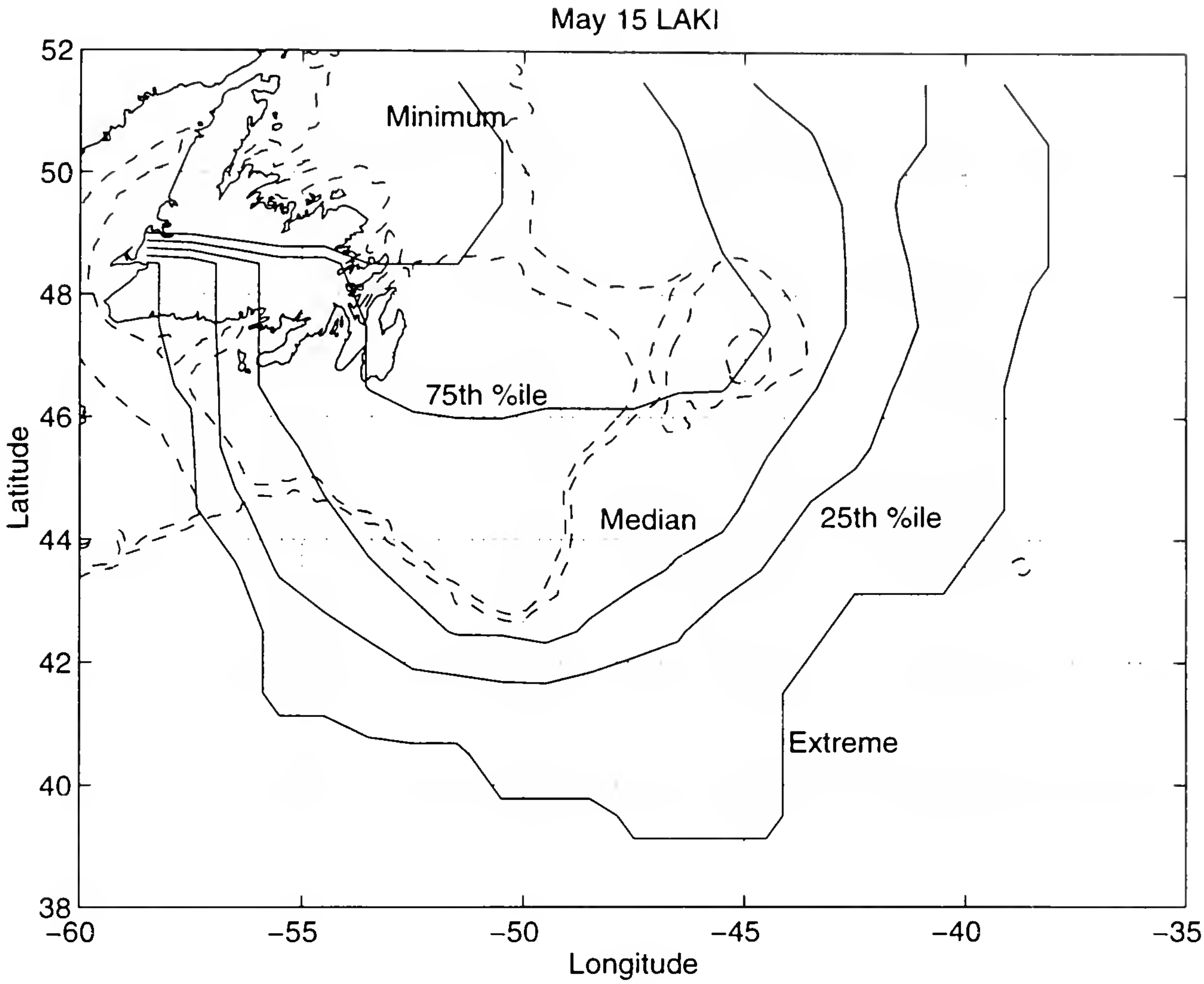


Figure 5

May 15 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

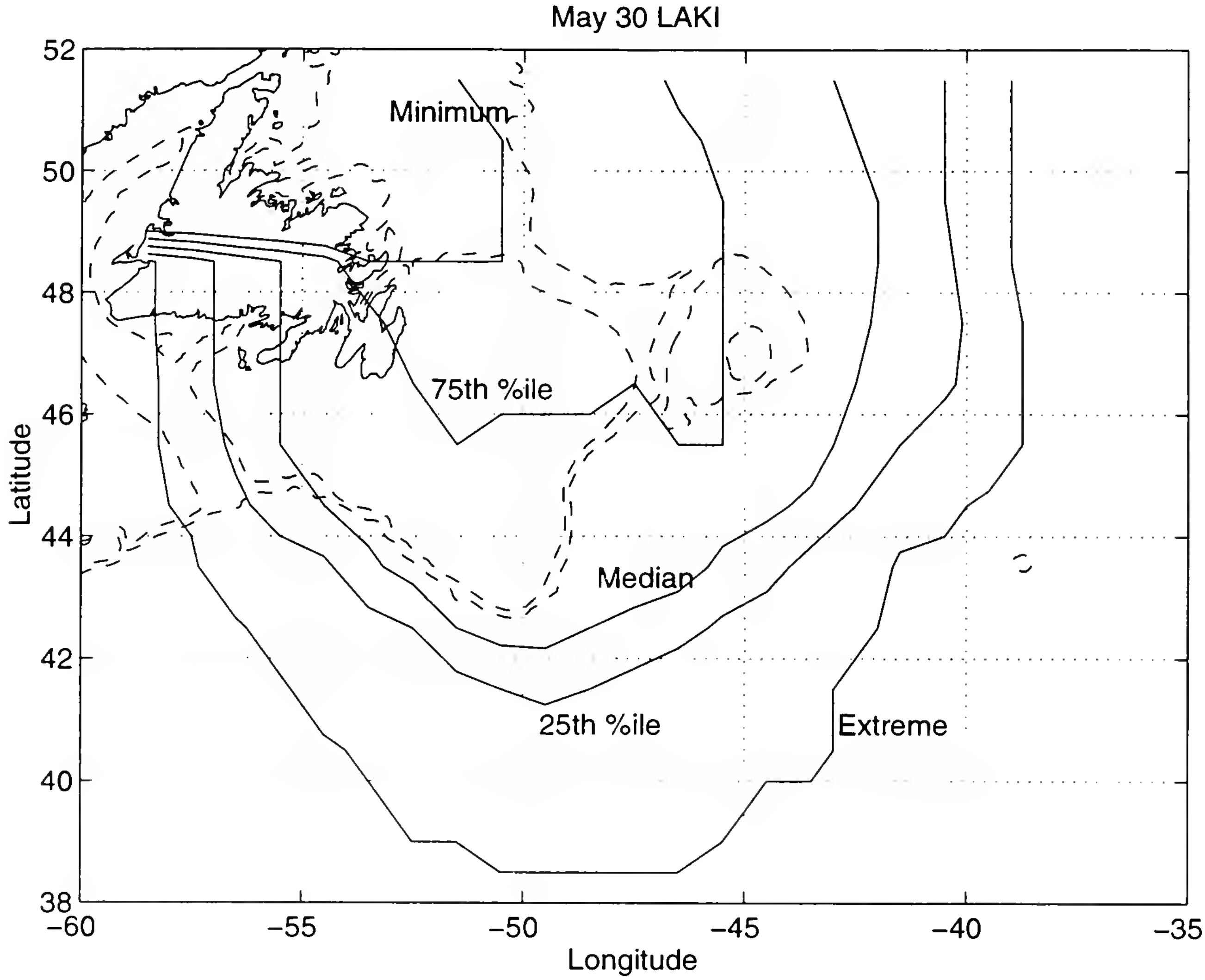


Figure 6

May 30 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

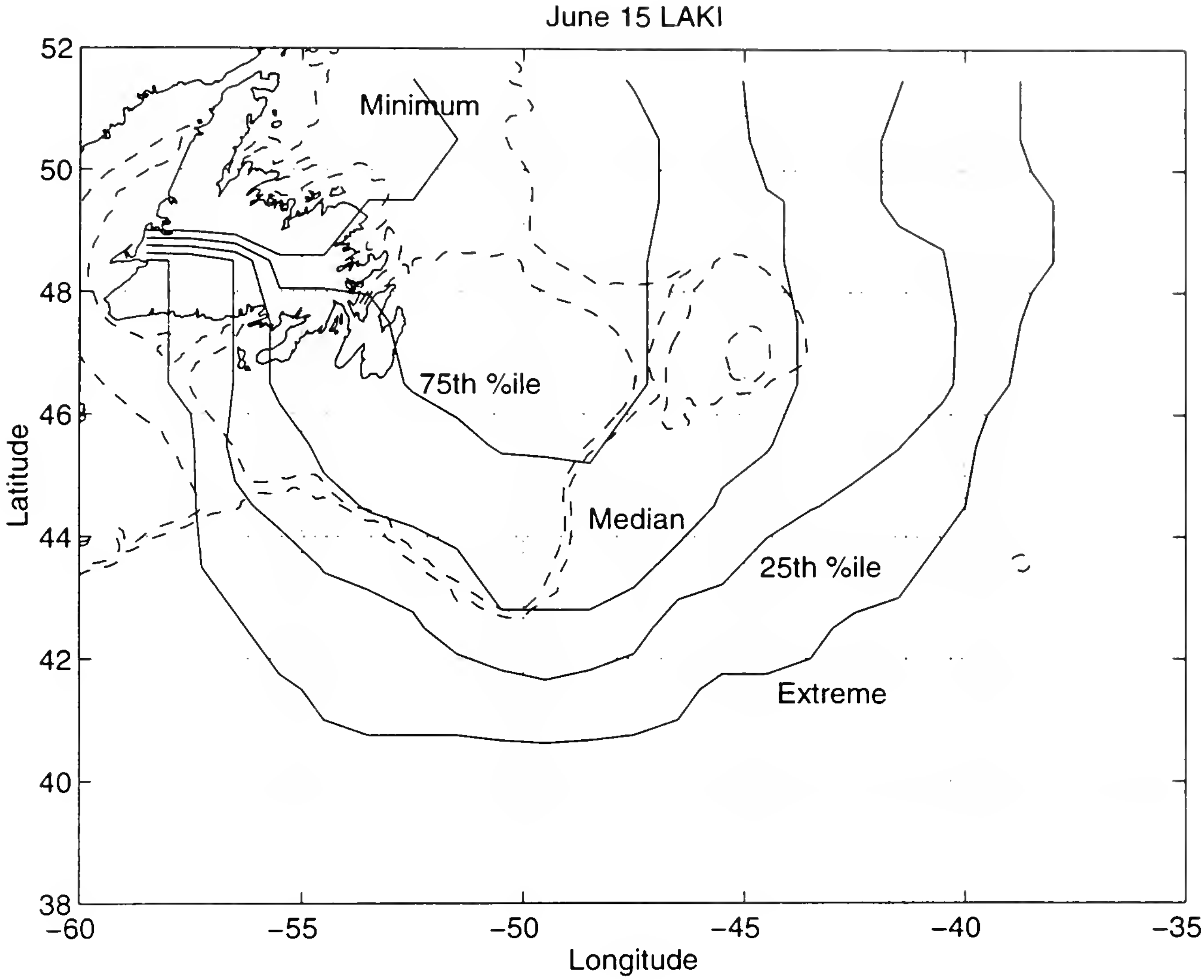


Figure 7

June 15 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

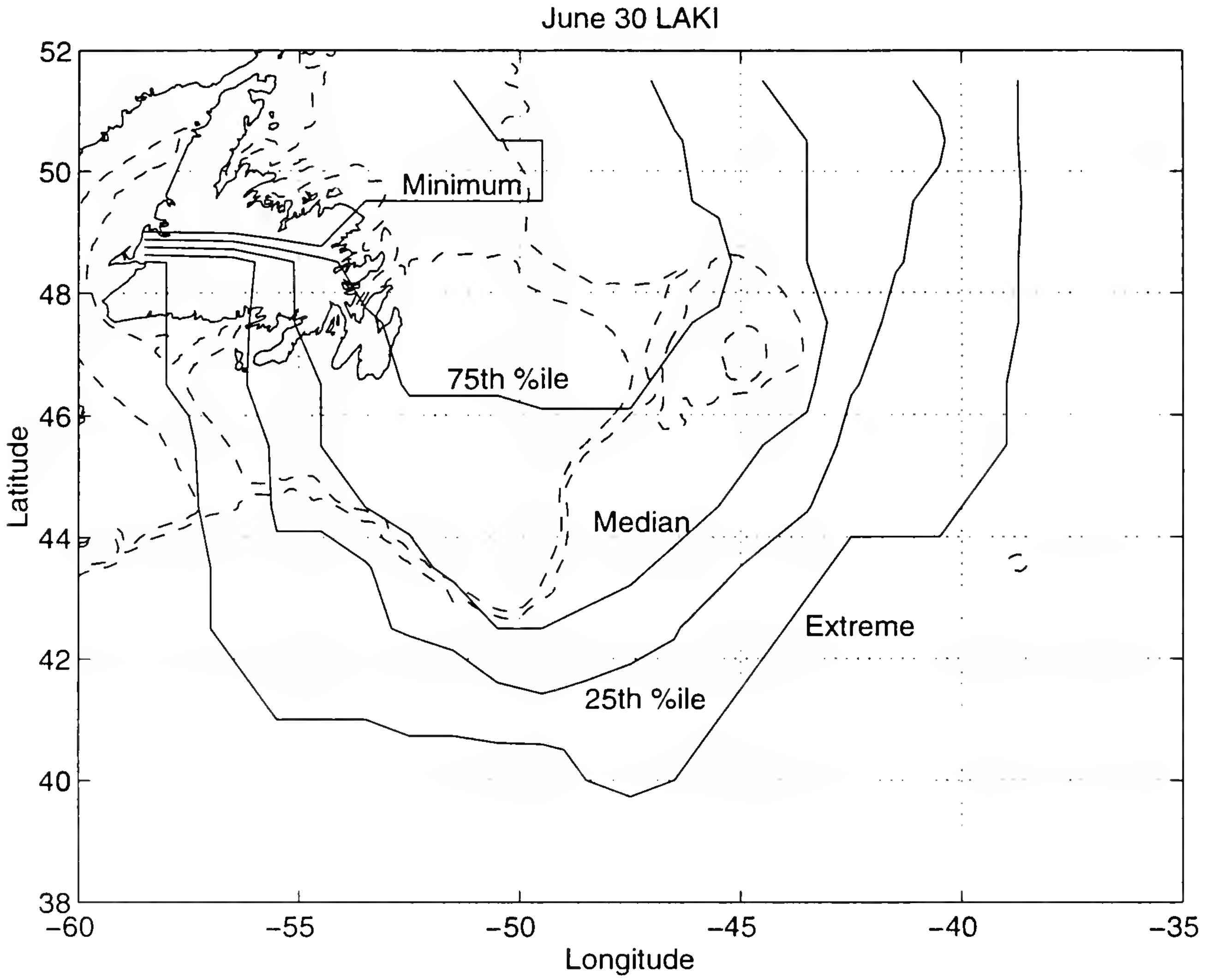


Figure 8

June 30 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

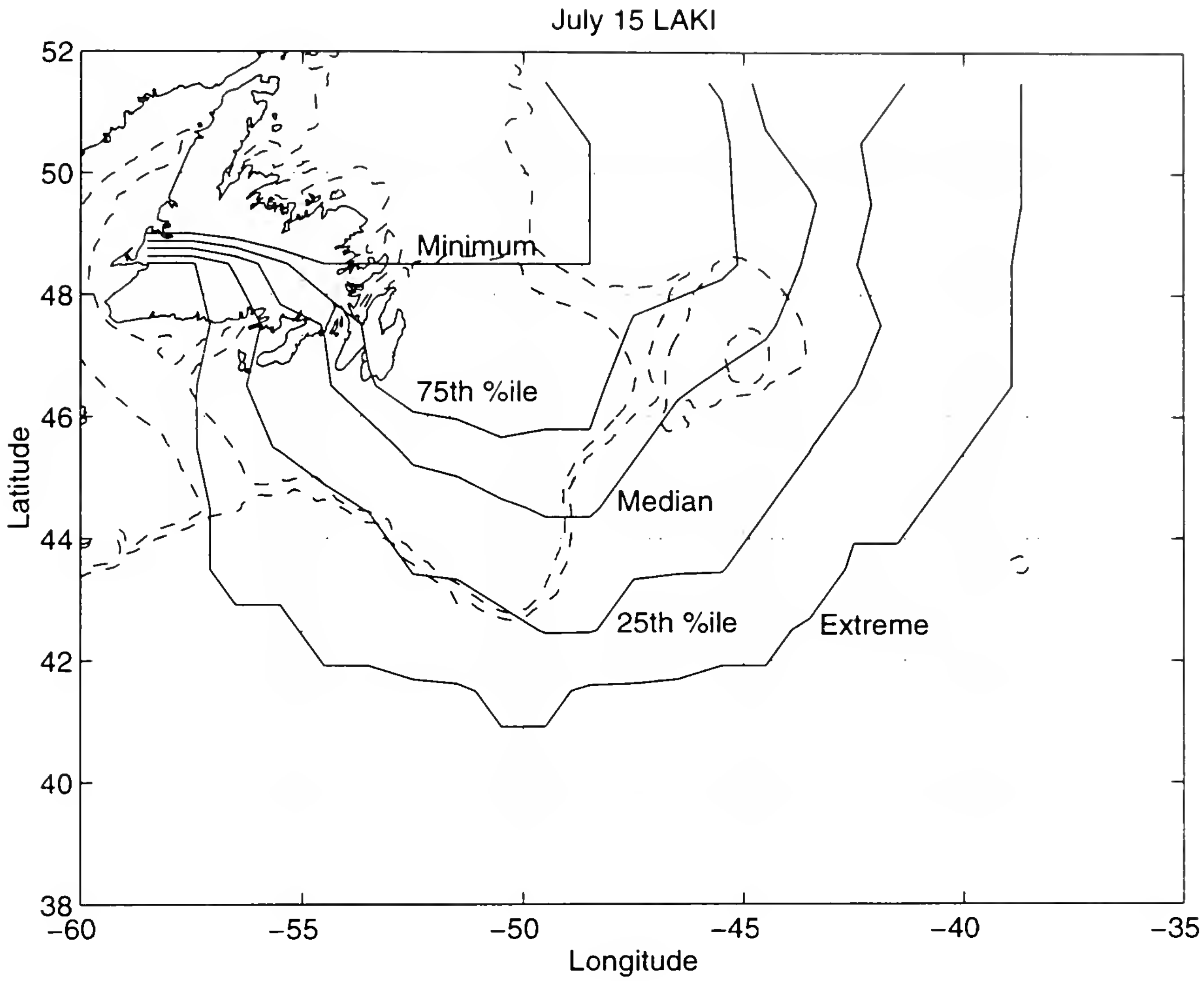


Figure 9

July 15 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

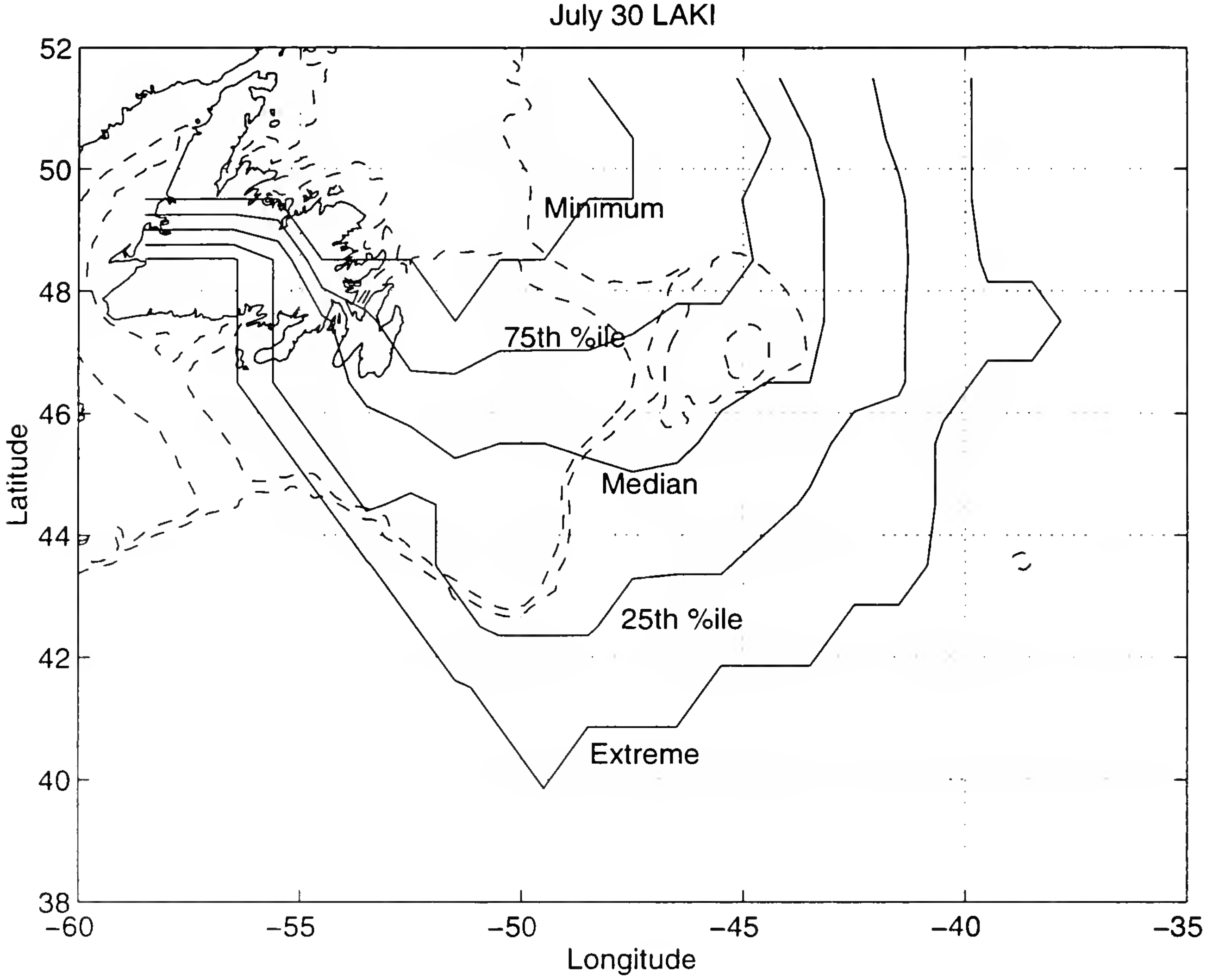


Figure 10

July 30 climatological Limits of All Known Ice (LAKI) based records of the LAKI from 1975-1995.

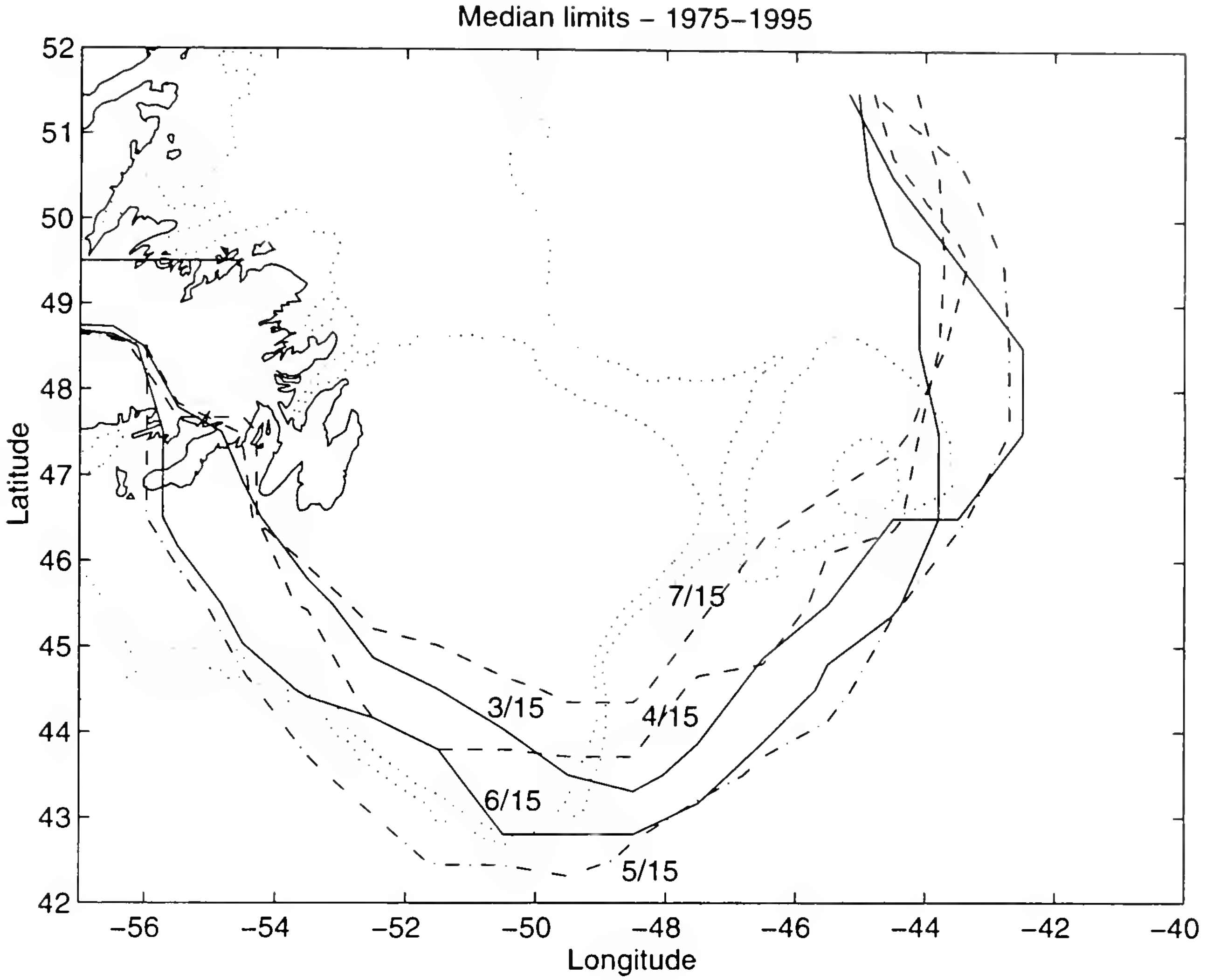


Figure 11

Median Limits of All Known Ice for 1975-1995. Contours are denoted by the adjoining label. March 15 and June 15 are shown by solid lines, April 15 and July 15 by dashed lines, and May 15 by the dot-dashed line. Dotted contours show the 200 m and 1000 m isobath. Note that the May 15 limit encompasses the most area.

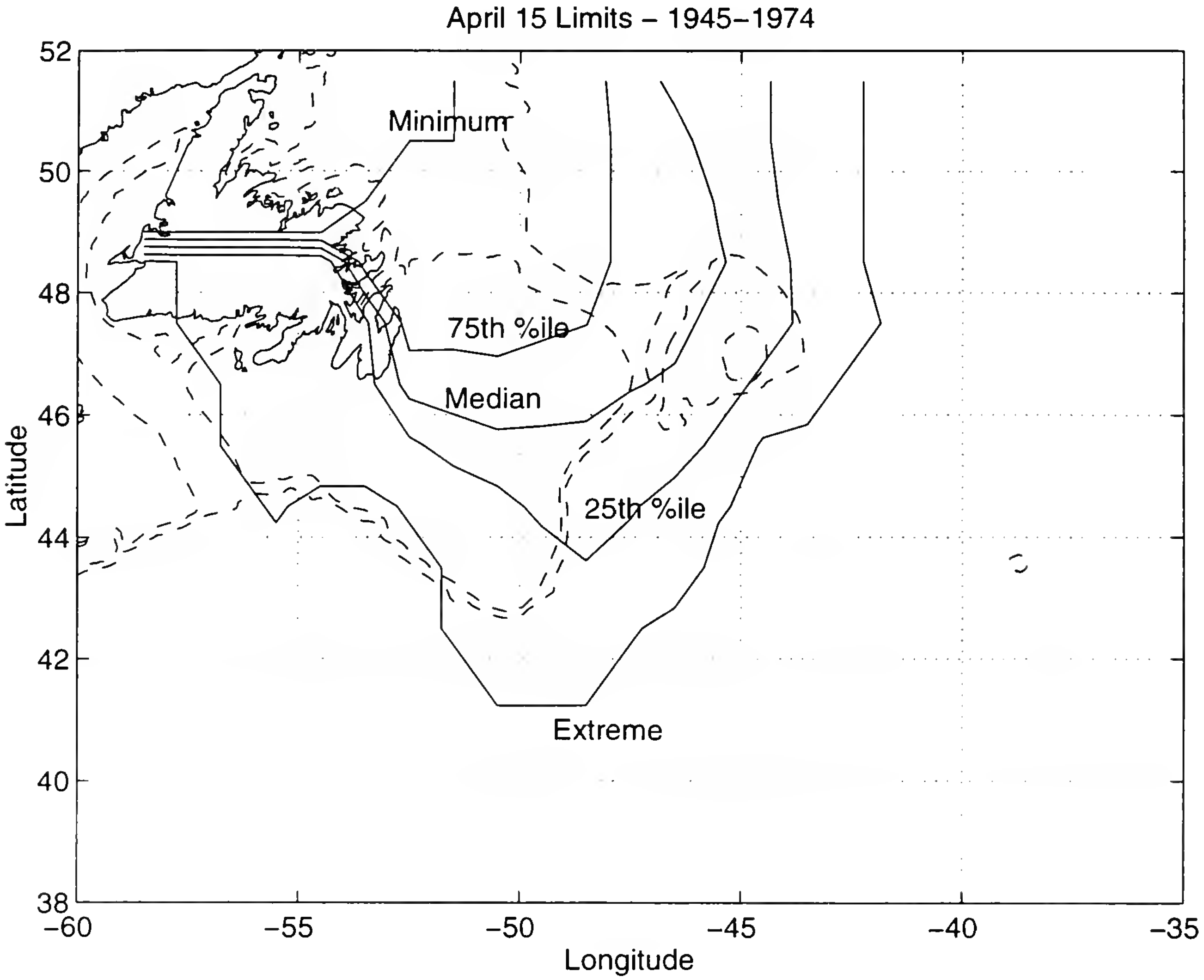


Figure 12

Climatological Limits of All Known Ice based on 25 years' iceberg sighting data near April 15 for the years 1945 to 1974. Data availability is given in Table 2.

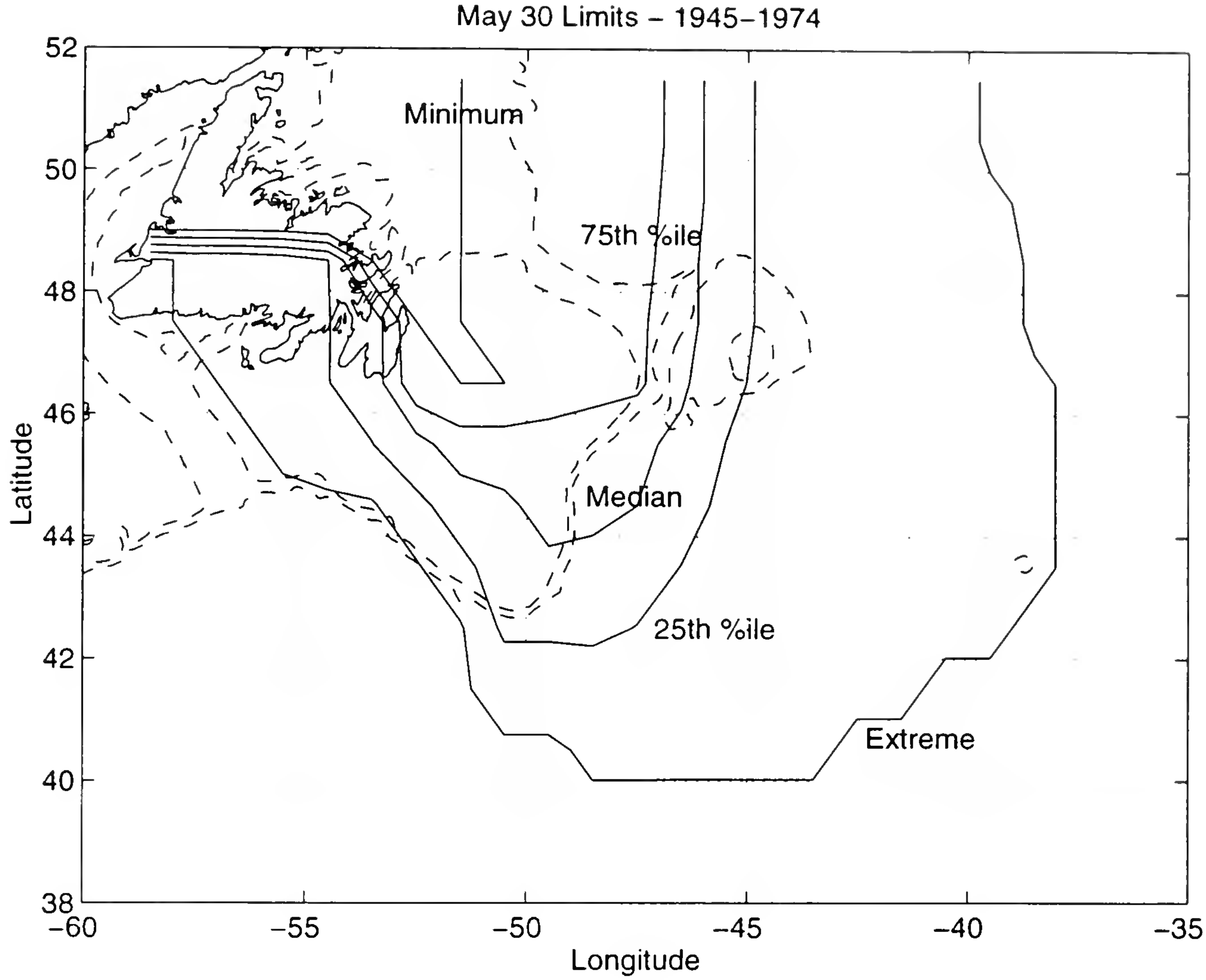


Figure 13

Climatological Limits of All Known Ice based on 25 years' iceberg sighting data near May 30 for the years 1945 to 1974. Data availability is given in Table 2..